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World's Most Powerful Dredge in Operation

Port of Portland's 3500 b.hp. Diesel-Electric Dredge, with Thirty-inch Pipe Line, Is Now Running on a Schedule of Twenty-four Hours Per Day

AFTER a trial attended by over 250 prominent business men of Portland, the huge Diesel-electric dredge CLACKAMAS, recently completed by the Port of Portland, Oregon, went into operation on a regular 24-hour day schedule, taking its place as the finest and most modern dredging plant in the United States.

For the trial the auxiliary engine was first started to provide power for the circulating water, piston cooling oil, lubricating oil systems, etc. Then each of the four large Diesel units was started and thrown in on the line, one after the other. W. C. Bristol, prominent admiralty lawyer of the Pacific Coast and a citizen much interested in port development, pressed the button that started up the main dredging pump. The dredge was put to work in sand and delivered approximately 2000 cubic yards of solid material per digging hour.

The CLACKAMAS has been in constant operation ever since and has given most satisfactory results. There have been no shut downs due to mechanical troubles of any kind. She is running on straight boiler fuel oil, with a consumption of about 75 bbl. a day.

Nozzle tests were run on the main dredge pump to determine its various characteristics and efficiencies. Very gratifying results were obtained, and the performance of the dredge and main pump more than came up to expectations, a pipe line velocity of 15 ft. per sec. being maintained through 8,000 ft. of pipe line.

The decision of the Port of Portland to construct the CLACKAMAS was made after a careful study of all the conditions which the new dredge would have to meet. The main designs were worked out by James H. Polhemus, general manager of the Port, who supervised the construction and installation of the machinery.

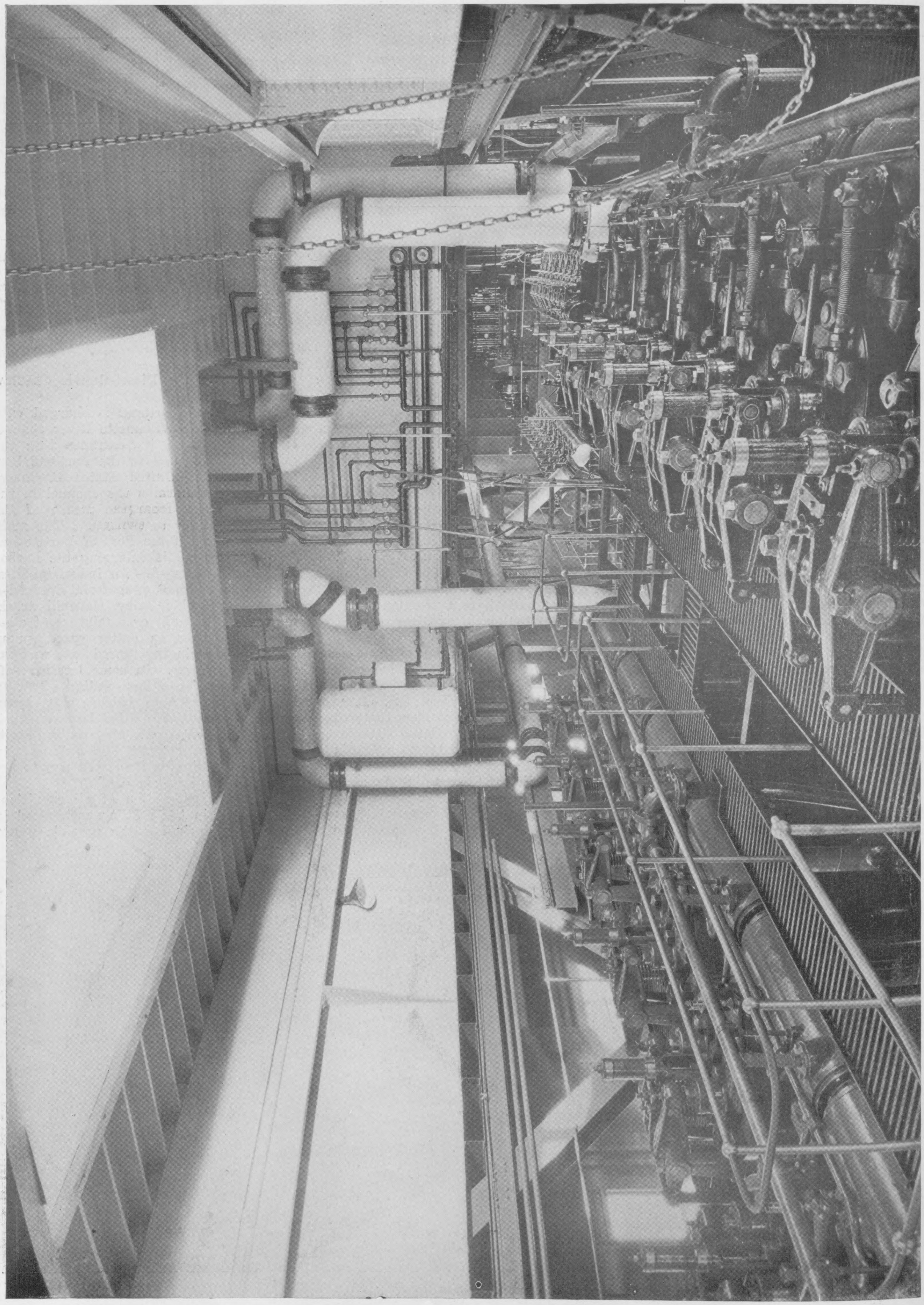
The dredging operations of the Port of Portland cover a wide range of conditions as to material excavated, location of the dredged area, depth of water desired, length of discharge pipe, terminal lift, distance of the area to be dredged from the source of fuel supply, etc. Dredging experience in the district with publicly maintained equipment dates from 1898, and study of the applicability of the pipeline dredge has been featured the last few years by the adoption of mechanical changes which have reached a high stage of development with the design of the Diesel-electric CLACKAMAS.

The Port of Portland is charged with maintaining the Willamette River channel from Portland to its entrance into the Columbia River and in the Portland harbor area. The United States Engineers Department maintains the channel in the Columbia River from the mouth of the Willamette River to the sea. The main dredging work of the Port of Portland at the present time is enlarging the harbor area and providing fills for industrial sites.

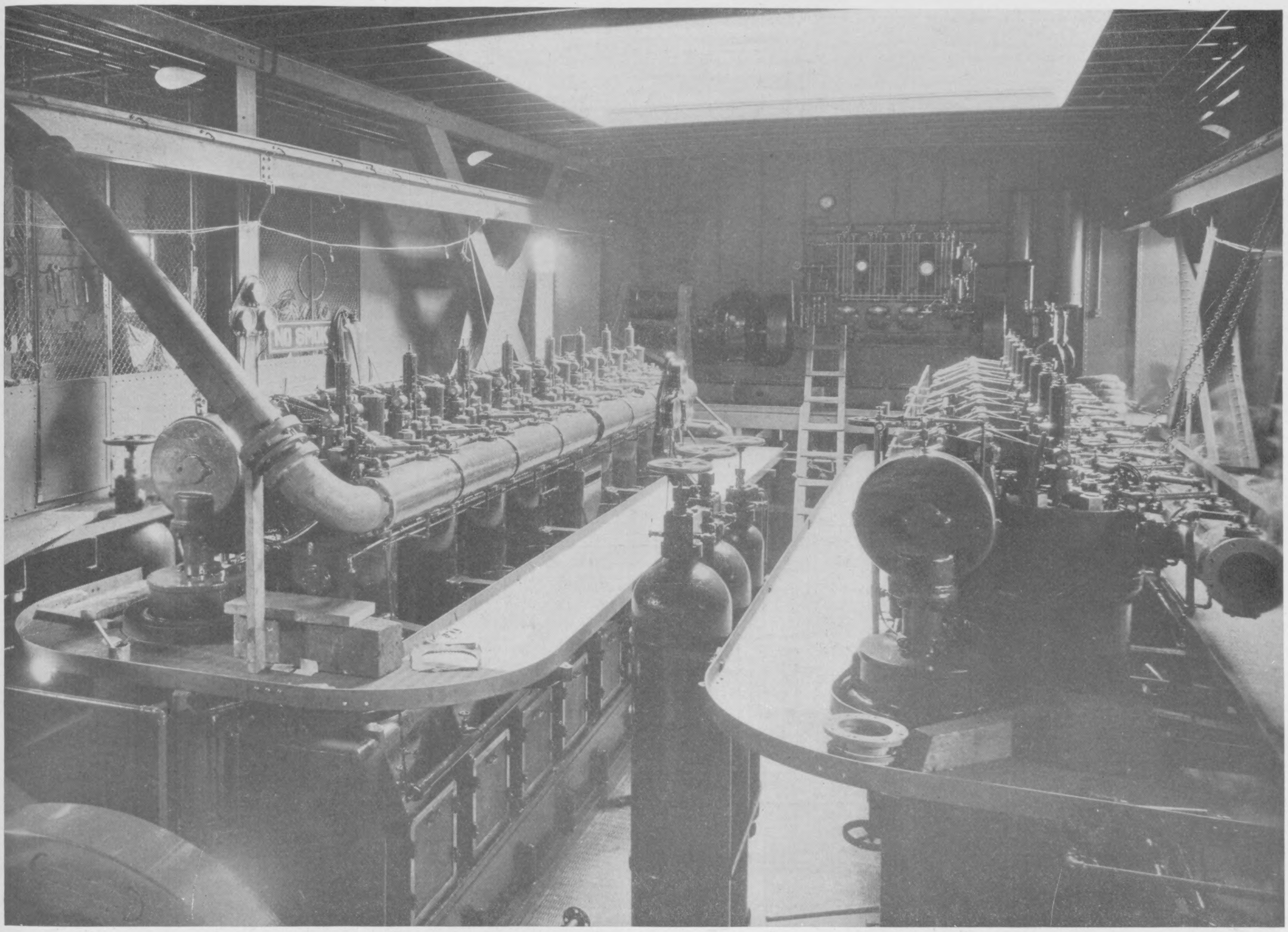
The various kinds of material dredged—heavy gravel, blue clay, sawmill trash, sharp sand, fine silt or a mixture of all—call for changes in cutter speed, pump speed and swinging speed as well as changes in power. In some locations efficiency calls for a long radius of swing and a deep reach of ladder, also strong spuds for anchoring. Other locations, such as narrow areas in pier slips, require limited breadth and compact hull outlines. In very shallow digging it is necessary to use a specially designed ladder.

From a consideration of all conditions encountered in the past or anticipated in the future, including the possible recur-

View of 3500 b.hp. dredge and pipe line



General view of engine room of Port of Portland's dredge Clackamas



Close-up view of engine room

rence of a shortage in hog fuel—the fuel used for the steam dredges—the port engineers of Portland decided upon the use of full Diesel engines of high power on account of their marked operating efficiency, full dependability and economy as compared with steam power.

To meet the dredging conditions, it was necessary that the speeds of the dredging pump, cutter motor and swinging motors be adjustable to the highest degree. It was desirable that the equipment should be as simple, reliable, rugged and flexible over a wide range of conditions as possible. These considerations demanded the transforming of the power of the Diesel engines into electrical power.

After a thorough investigation, it was decided that direct current equipment was particularly well suited to meet the special conditions under which it is intended this dredge will be operated. One desirable feature of the system selected is that direct-current machinery is well understood by most engineers and operators, so that it can be left in the hands of men of average ability and training and not require the services of a highly trained technical expert.

The main driving machinery of the CLACKAMAS consists of four McIntosh & Seymour Diesel engines. Two are of 800 hp. and direct connected to 540 kw. d.c. generators and two of 900 hp. each connected similarly to two 610 kw. d.c. generators. These generators deliver power at 500 volts to the main bus. About 85 per cent of this power is used for the operation of the main pump motor, and the balance is used to operate the various auxiliary equipment described in detail later.

It would have been more satisfactory to have had all the main engines of the same horsepower, but several years ago the Port of Portland had an opportunity to purchase two 900 hp. units from the United States Shipping Board. Realizing that they would soon be in the market for power equipment on account of their increased activities and knowing the remarkable efficiency of the Diesel engine, the Port authorities made the purchase.

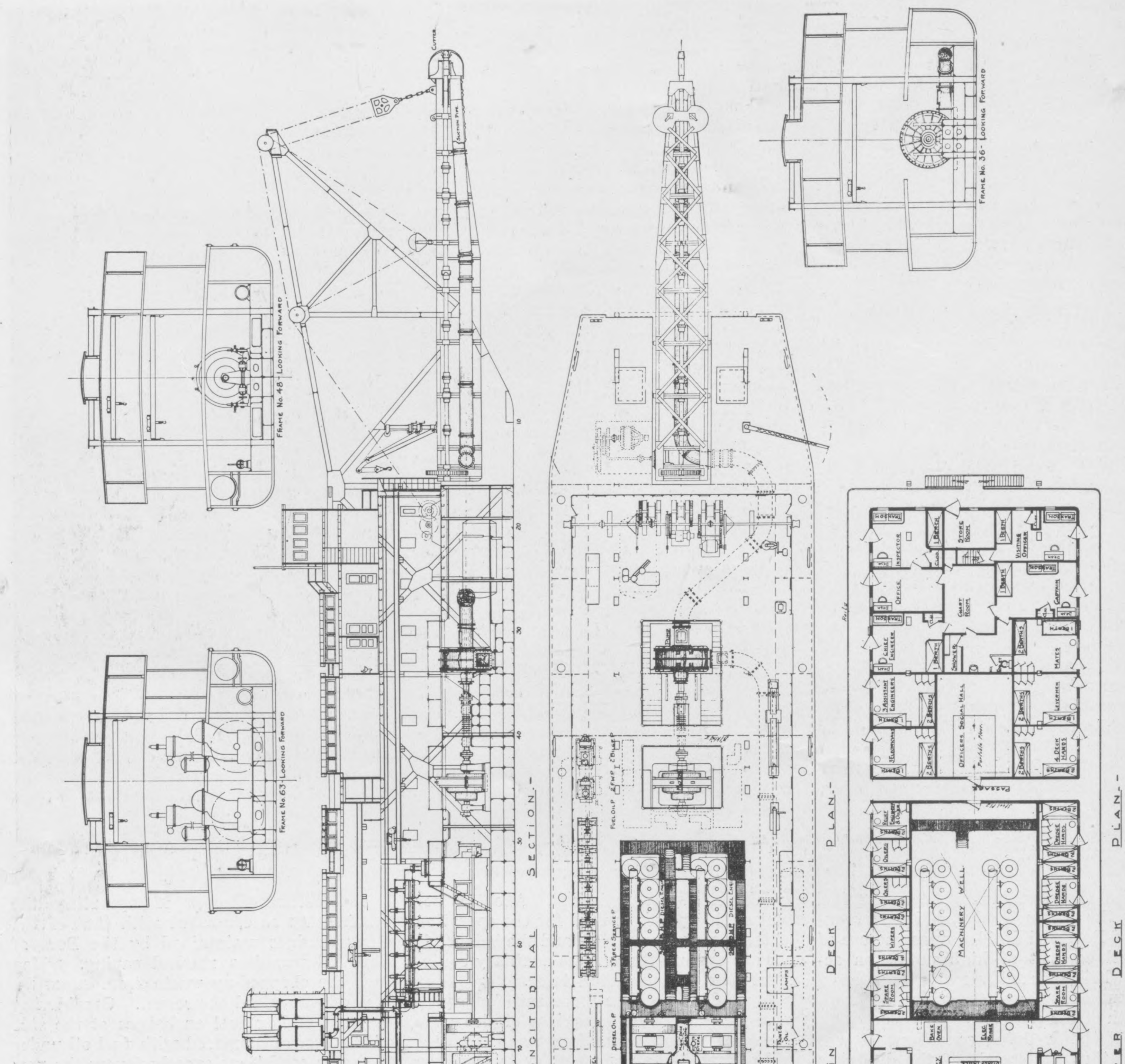
The necessity of increasing the dredging fleet and the desirability of standardizing the equipment determined the design of a 30-inch dredge. The inadequacy of these two Diesel engines to furnish enough power for the type of dredge required, necessitated the purchase of the two 800 hp. units. The CLACKAMAS was designed to fit these assembled units.

The 800 hp. units are 8-cylinder engines of the 4-cycle trunk type and each at full power turns 200 r.p.m. The 900 hp. engines are 6-cylinder units of the 4-cycle trunk type, each at full power turning 150 r.p.m. The combined power is 3400 b.hp., and the total consumption of fuel oil at full power is 4¼ bbl. per hour or 102 bbl. per day of 24 hours. The final report on the fuel consumption has considerably bettered this estimate.

The estimated cost of operating the CLACKAMAS as compared with that of the other dredges maintained by the Port of Portland promises marked saving. Hog fuel, the chopped-up waste from sawmills, is very low priced at present. Considering the cost of hog fuel on barges at the side of the dredge compared with fuel oil under the same conditions greatly favors the new dredge.

The CLACKAMAS will deliver power to the dredging pump (after losses of electric conversion) at 72 per cent of the cost per horsepower on the other dredges, without considering the labor cost of transferring the hog fuel to the furnaces. Considering the delays for cleaning fires, wages of fireroom crew and the power required for steam auxiliaries, which at times is 42 per cent of the total power as compared with that for electric-driven auxiliaries, which will be between 10 and 15 per cent, the economy of a Diesel-electric dredge is more evident. Using fuel under boilers on the other dredges—which has been necessary during a shortage of hog fuel—the cost per horsepower at the pump is more than four times what it is on a Diesel-electric dredge.

With the engine power in four units, the total weight of the plant is reduced; and the electric generators, because of the higher rotative speed, are smaller, which reduces the size of spare parts and makes it easy to handle any repairs that may become necessary. Many such repairs can be



Longitudinal section, deck plans and transverse sections of the Port of Portland's Diesel electric dredge Clackamas designed by James Polhemus; total engine capacity, 3500 b.hp.

taken care of with the shop equipment on the dredge and by members of the dredge crew.

Having four units, it is possible to stop one and obtain approximately 80 per cent efficiency with the remaining three. Thus a breakdown of one unit would not seriously hinder the operation of the dredge. On short pipe lines it might at times be desirable to shut down one or more of the engines. The installation of four large engines makes it also possible to shut down one engine for overhauling without interfering with the operation of the dredge.

The fuel oil and Diesel oil pumps are of the Northern rotary type. There are two fuel oil pumps, 125 g.p.m. at 100 lb. pressure, 10-hp. motors and one Diesel oil pump, 125 g.m.p. at 100 lb. pressure, 10-hp. motor.

The CLACKAMAS presents a very interesting study from the viewpoint of the installation of the electrical machinery. All the power, including that for raising the ladder, swinging the dredge, raising the spuds, etc., is electrical. All electrical equipment was furnished by the Westinghouse Electric and Manufacturing Co.

There are four d.c. generators of the compound-wound, commutating-pole type, direct connected to the main Diesel engines. The compound winding on these generators is only sufficient to compensate for the variations in speed of the Diesel engines as found by experience.

The two 540 kw. generators direct connected to the 800 hp. units and the two 610 kw. generators connected to the 900 hp. units deliver power at 500 volts to the main bus. This allows for great flexibility, simplicity and efficiency of control and operation. The main engines may be operated either singly or in any combination, and the speed of the dredging-pump motor and cutter motor can be varied to suit the power available or the conditions of operation.

About 85 per cent of the total power is taken from the bus for the operation of the main pump motor. The remainder of the electric equipment operates at a lower voltage, and to obtain this conversion a balancer set is introduced consisting of two 250 volt machines coupled together and operated in series from the main bus. A lead from the common connections of these two machines, in conjunction with the two leads from the main bus, forms a 250-500 volt three-wire system. By distributing the 250 volt motors on each side of the neutral lead, it is possible to obtain a good natural balance, so that very little power will actually pass through the balancer set and there will be practically no power loss.

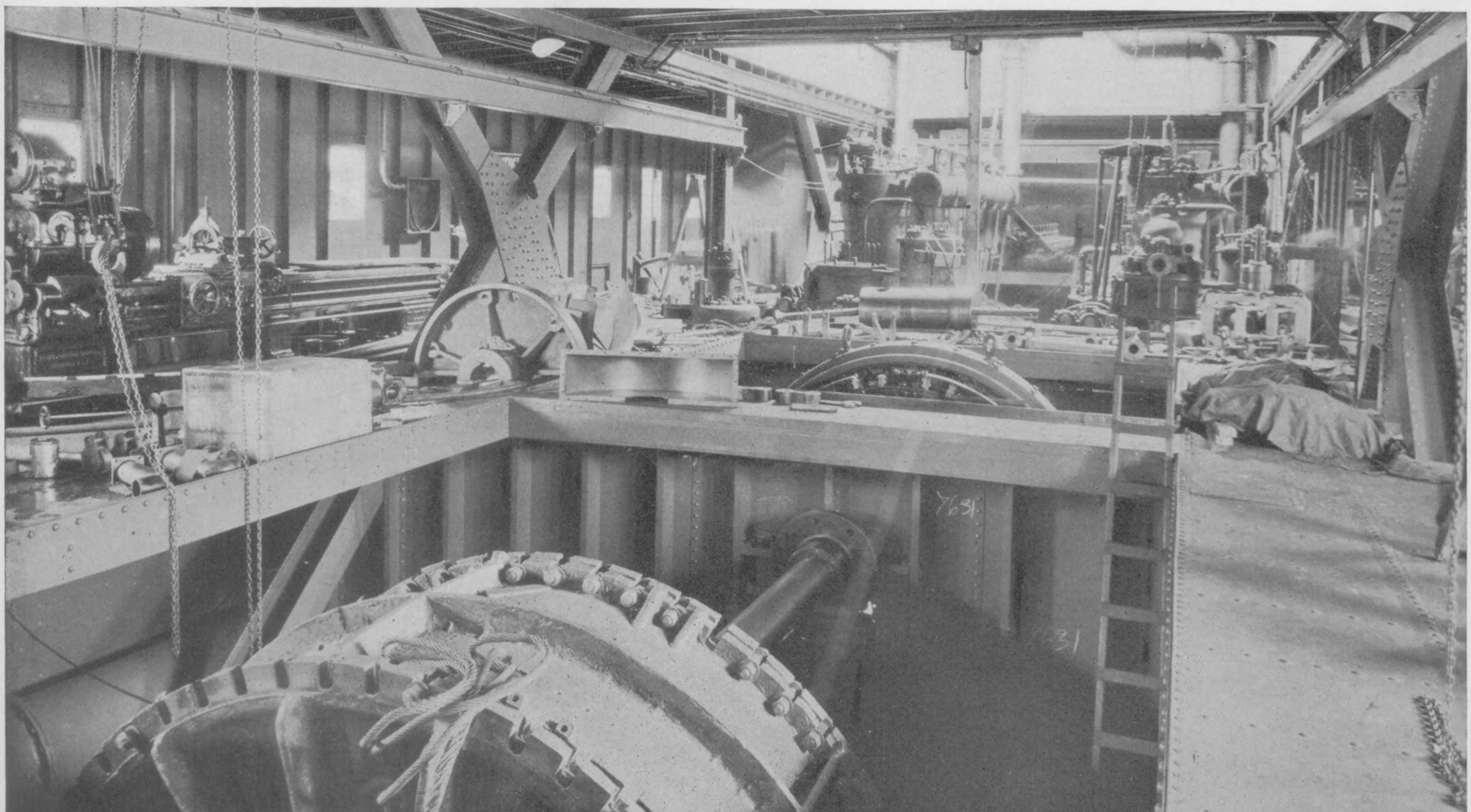
The balancer units are made large enough to act as motors to drive three generators. One generator furnishes power for operating the cutter motor by the variable-voltage or Ward Leonard system. The second generator provides power for operating the forward swing motor by the same system. The third, a 125-250 volt d.c. three-wire generator, is for lights, excitation of variable-voltage generators, small motors, and auxiliaries. There is a 75 kw. 125-250 volt three-wire auxiliary generator direct connected to a 100-hp. 4-cylinder Atlas-Imperial Diesel engine which supplies power to the three-wire system when the main generators are shut down.

The dredging pump for the CLACKAMAS is a high speed, square-volute lined centrifugal pump developed by the Port of Portland, having 30-inch suction and discharge openings. The casing is rectangular in section and 8 ft. 10½ in. diameter inside of the liners. It is made of cast steel to provide extra strength and reduce weight. This reduces the possibilities of breakage from boulders or water ram and also facilitates patching by electric welding.

The impeller, which is screwed on to the pump shaft so that it may be more readily removed to replace back head liners, is of the four-spiral-vane enclosed type, 70 in. diameter and driven at speeds ranging from 250 to 360 r.p.m. On account of this wide range of speed adjustment, it is believed that all dredging conditions of long or short discharge pipe, light or heavy material being dredged, or amount of terminal lift, etc. can be met without changing the size of the impeller.

The pump motor is a 2700 hp. 250 to 360 r.p.m. 500 volt adjustable-speed, compound-wound d.c. machine direct-connected through a flexible coupling and marine horseshoe-type thrust bearing to the dredging pump. It is the largest motor of its kind ever built for dredging purposes. The compounding is adjustable to give a no-load speed of 450 r.p.m. and a full-load speed of 360 r.p.m., and the motor has a rising speed characteristic, giving additional velocity and maintaining torque to clear the discharge-pipe line in case of chokings.

The pump motor is controlled by motor-driven rheostatic controllers operated by push buttons. Pushing the starter button located on the engine-room switchboard starts the motor and it runs up to speed automatically. The last point on the controller closes the circuit breaker, cutting



Construction picture of Clackamas, showing pump in foreground; main motor and beds of Diesel engines in background

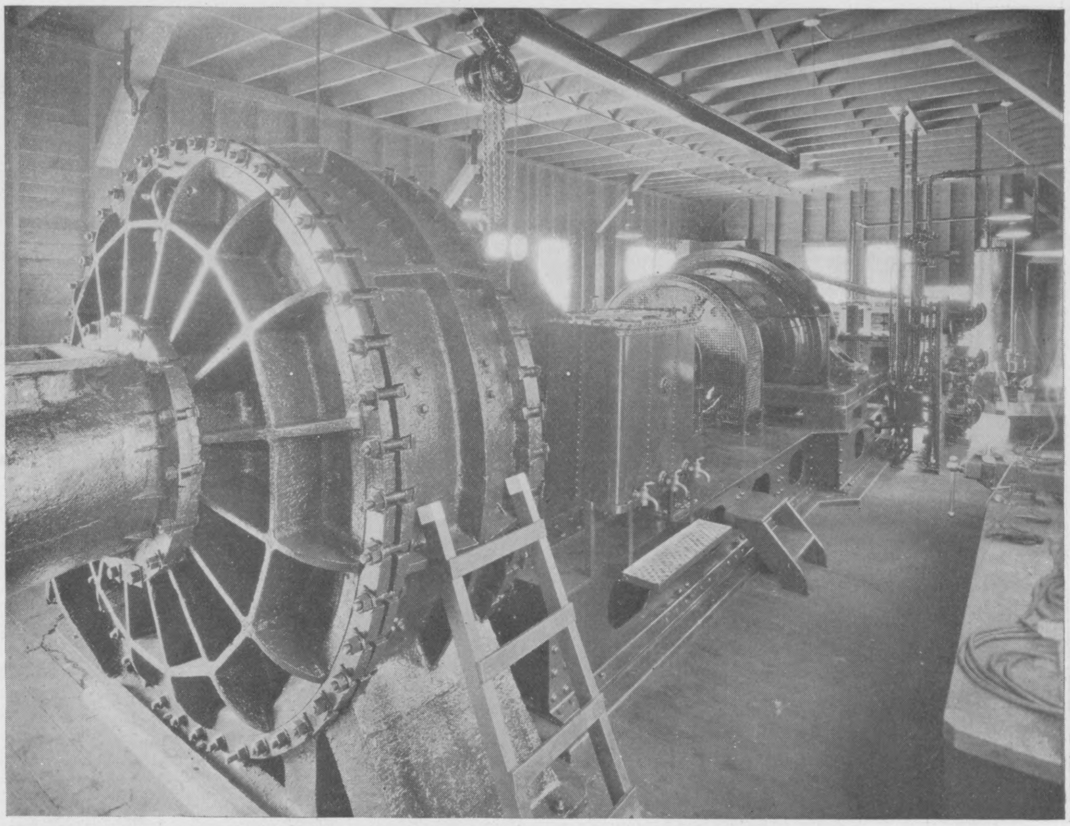
The immensity of the dredge Clackamas is shown in this reproduction. She is said to be the world's most powerful dredge

out the starter, and leaving the motor operating at a speed corresponding to the position of the motor-operated field rheostat. Speed adjustment is then obtained by pressing the "fast" or "slow" buttons either on the panel in the engine room or similar buttons in the pilot house. When the speed has reached the desired point, as shown by the indicator, the button is released, and the speed stays at that point as long as power is available at the main bus.

For emergency operation an "inching" push button is provided in the pump room. This causes the motor to turn very slowly for making repairs or cleaning until stopped by releasing the push button. A reversing field switch on the engine room switchboard will allow the pump motor to operate in the reverse direction up to full speed if desired. The small motors for the control rheostats obtain their power from the 125-250 volt generator forming a part of the balancer set.

The cutter is driven by an electric motor through a chain of gearing. Two of the gears in this chain are made interchangeable so that the maximum speed, 12 r.p.m., of cutter, at maximum motor speed can be practically doubled to 25 r.p.m. The cutter motor, located below the main deck in the forward port wing, is a 250 hp. 600 r.p.m., 275 volt shunt-wound, separately excited machine connected to the cutter drive by a Thomas flexible coupling. It receives its power from the 200 kw. generator of the balancer set, and is controlled by a reversing drum controller, located in the pilot house, providing 14 speed points in either direction by controlling the shunt-field excitation of the generator and thus producing the variable voltage of the Ward Leonard system.

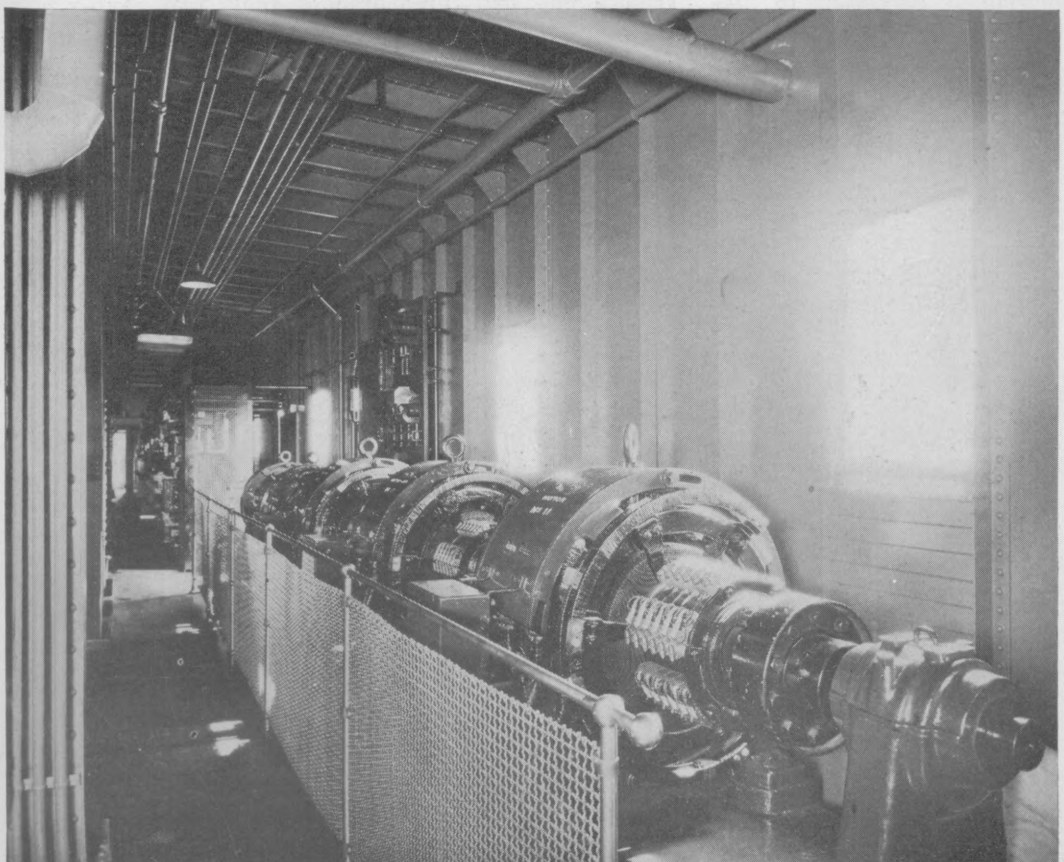
The dredging ladder is the standard Port of Portland type, 75 ft. long, 10 ft. wide and 8 ft. 6 in. deep. The cutter shaft is located



Motors and centrifugal pump in one of the compartments

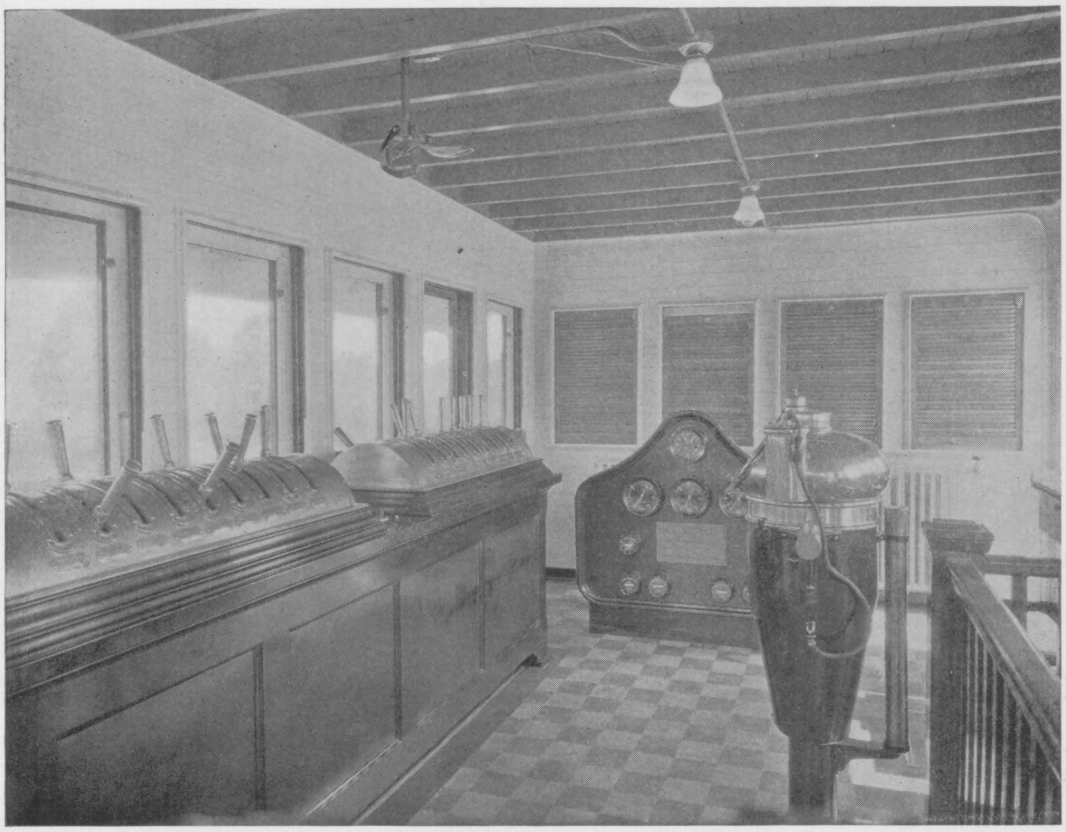
inside of the ladder and carried in bearings near the top. The suction pipe is also inside the ladder, carried in saddles near the bottom.

The switchboard, located on the port side of the dredge, on the main deck in the engine room, is made up of 17 panels. The equipment of these panels is as follows: Panel 1: water, oil and air pressure gauges, electric pyrometer and a multiple-contact pyrometer switch of 32 contacts; Panel 2: graphic meters for the forward swing motors and the cutter motor; Panel 3: Circuit breaker, ammeter, rheostat, handwheel, voltmeter switch, field discharge switch, two heavy knife switches, watt-hour meter with knife switch, and magneto-operated speed indicator for control of the 610-volt generators; Panels 5, 6 and 7 are duplicates of Panel 4, used for control of second 610 kw. generator and the two 540 kw. generators. Panel 8 is for the dredging pump motor and contains the electrically operated circuit breaker and field switches; Panel 9: For control of feeder to 2700 hp. dredging-pump motor; has four sets of heavy knife switches, a graphic wattmeter and a watt-hour meter as well as an 8-day clock; Panel 10: Controls of the balancer set; Panel 11: Feeder panel for the balancer set; Panel 12: for 250 volt feeders; Panel 13: Has 16 two-pole switches for 250 volt feeder with fuses; Panels 14-15: Duplicates of Panel 13, the first for control of the 75 kw. auxiliary generator, the second for the control of the 60 kw. generator of the balancer set; Panel 16: Contains a three-pole manually operated circuit breaker with shunt trip and 12 two-pole knife switches with fuses; Panel 17: contains gauges, graphics and push buttons for control of the cutter motor and main pump motor.



View showing motor balancing set

On the main deck of the dredge near the forward bulkhead of the house is installed a three-drum winch equipped with clutches, brakes and gypsy heads. Two of these drums are driven through clutches and gears by a layshaft extending across the lower steel house and through the side walls, with a gypsy head on each end outside the house. This layshaft is driven through a train of gearing by a 75 hp. 600 r.p.m. 230 volt motor of heavy open construction which takes its power from the 60 kw. generator of the balancer set. This machinery is used for raising and lowering the ladder. Mounted on the same frame are the drums for swinging the dredge from side to side, cables from which run to heavy anchors on either quarter of the



Clackamas has remarkable arrangement of power house controls

dredge. They are essential for this work.

On the main deck aft of the 800 hp. engines is installed an auxiliary 110 hp. 4-cylinder Atlas-Imperial solid injection Diesel engine direct connected to a 75 kw., 325 r.p.m. 125-250 volt three-wire compound-wound d.c. generator. Installed on the same foundation is a small gasoline-driven air compressor for furnishing air for the auxiliary engine in case the air tanks become exhausted. The auxiliary generator delivers current to the bus on the main switchboard for operating the pumps, machine tools, lights, galley equipment and other auxiliary machinery when the main engines are not operating, as on Sundays, holidays or during repair periods.

Installed on the main deck forward of the balancer set, on the port side are two Rix motor-driven air compressors. One of these is a two-stage compressor driven by a 25 hp. electric motor and delivering air at 50 lb. per sq. in. pressure, the second is a booster compressor driven by a 10 hp. motor receiving air at 350 lb. per sq. in. from the two-stage compressor and delivering it at 1000 lb. per sq. in. where needed. These compressors have interconnecting air piping to all air tanks and air bottles to fill them in case they become exhausted and the main engines are all idle.

There are a number of motor-driven auxiliary pumps installed below the main deck, most of them against the longitudinal bulkhead on the port side. In many cases there are duplicate pumps used for the same service, to allow repairs to be made without interfering with the operation of the dredge. In some of the more important systems the duplicate pump is placed in a different compartment than its mate so that the system will not be deranged in case of a flooding of one of the compartments.

The CLACKAMAS is equipped with a Sharpless centrifuge machine for the cleansing of all oil used. The Port's experience with lubricating oil has induced them to install this system as a means of protecting not only the lubricating oil system, but also the fuel oil for the main engines.

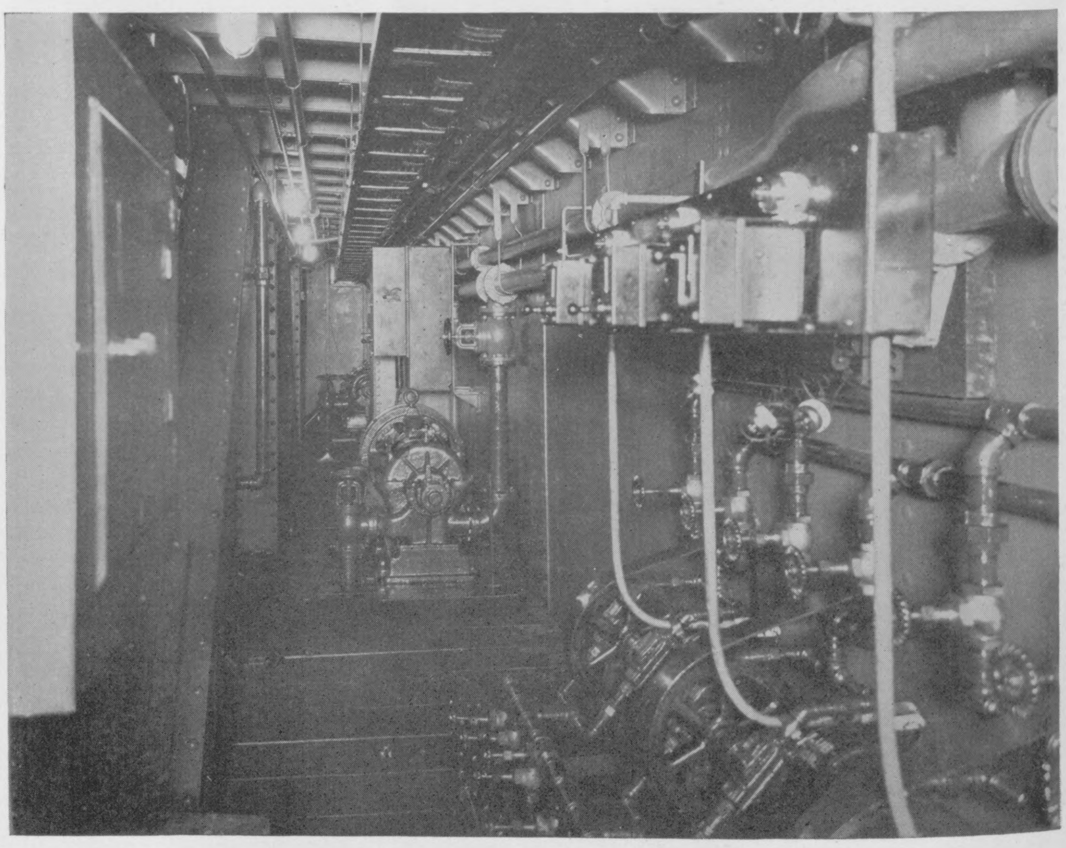
The CLACKAMAS is also equipped with a Frick self-contained refrigerating machine of two tons refrigerating capacity, belt driven by a 3 hp. d.c. motor which furnishes refrigeration for the $7\frac{1}{2}$ ft. by 10 ft. cold storage room, the ice-making brine tank and the scuttle hold. The machine shop is located on the main deck and consists of all equipment necessary to make repairs on the various machinery on the dredge.

There are three Cyclops Iron Works hand-operated traveling cranes installed. One of 10 tons capacity is over the two 800 hp. main engines and the other over the 900 hp. engines. The third crane, of 5 tons capacity, operates from the forward part of the 900 hp. engines to the forward bulkhead of the lower house, and serves the dredging pump and motor, the heavy machine tools and the forward winch. These cranes in conjunction travel the length of the machinery space, and it is possible to transfer a load from one to the other.

The hull of the CLACKAMAS is built of steel and is 236 ft. long by 50 ft. beam and 12 ft. 9 in. deep. At 7 ft. 8 in. draft it will displace 2480 tons. In an emergency the CLACKAMAS has tankage for 3,948 barrels of fuel oil, more than two months' supply under probable working conditions of 66 per cent of time at full power. Tankage is provided for 29,954 gal. of water and 7702 gal. of lubricating oil, more than seven months' supply of the latter.

The construction of the dredge is everywhere of the strongest, provision being made for the heaviest strains which would be encountered. On each side of the hull, located 7 ft. inboard from the shell plating, is a longitudinal watertight bulkhead extending from the forward athwartship bulkhead to the after athwartship bulkhead some 188 ft. in length. This strengthens the hull and particularly strengthens the bottom in case of grounding. The space between this bulkhead and the side of the hull is divided by athwartship partitions into six watertight compartments in each side of the ship.

In case of a side collision the probability is that the damage would not extend through 7 ft. of steel plating, two heavy oak fender strakes, stringers, etc.; thus only one, or perhaps two of the compartments would be flooded, with no danger of sinking the dredge. The Port of Portland has had three dredges sunk, two having been rammed by steamers and one by the burst-



View showing under-deck pumps

ing of the pipeline, so these precautions are wise.

These watertight compartments are used for the storage of fuel oil, Diesel oil, lubricating oil and water, thereby saving space which otherwise would be taken up by separate tanks, as well as conserving as to their weight and cost.

There are four transverse bulkheads dividing the hull into six compartments. The forward bulkhead is located at the after end of the ladder well, and is the after bulkhead of a compartment on each side of the well. The second bulkhead is 48 ft. aft of the first and is placed between the dredging pump and the pump motor. The third is 72 ft. back of the second and is placed between the forward set of 900 hp. engines and the after set of 800 hp. units. The fourth bulkhead is 60 ft. farther aft, giving a stern compartment 24 ft. long.

These bulkheads strengthen the dredge through being placed between the different main machinery units and thoroughly tying the machinery keelsons to the longitudinal bulkheads and the side of the hull. In addition there is a heavy frame 4 ft. 2 in. deep tied to each panel point of the truss, extending to the longitudinal bulkheads and the side of the hull, with additional deep frames 6 ft. apart tied to the longitudinal bulkheads.

It will be noticed that the aft engines and their generators are in one compartment. The forward engines and their generators are in another, and the main dredging pump is in a third. Should the bottom of the dredge be injured, causing the filling of any one of the compartments, the damage would be local and affect the electrical equipment in that compartment only. Similarly, should a hull pipe or the dredging pump be ruptured from any cause, the damage would be limited to the compartment where the damage occurred.

There is a heavy bridge-type steel truss extending the full length of the hull, the forward end being extended to form the A-frame for the ladder hoist and the spud masts aft being tied into, and forming a part of, the truss. This truss is calculated to support the weight of the dredge in case of grounding on two ends. Each of the two side trusses is located one-half the distance from the centerline of the hull to the side plating. There is ample space between the truss and the longitudinal bulkhead for a passageway and auxiliary pumps on the port side and for the hull pipe and passageway on the starboard side.

The panel points are spaced 36 ft. apart and the angle of the diagonal members is approximately 45 degrees. Forward of the deck house the top member of the truss converges, meeting the forward member of the A-frame 32 ft. forward of the bow. At this location a structural steel frame is formed, carrying five sheaves for the ladder hoist tackle, the lower member of which consists of a quadruple sheave block chained to the digging ladder near the outer end. The after end of the truss is built into the spud-well frames and spud-mast frames. The spud masts are sufficient in height to accommodate the 80 ft. spuds and so designed that they may be used to unship or ship a spud in case of breakage.

Each spud is 35 in. diameter and 80 ft. long, constructed of ¾-inch steel plates rolled into a cylindrical tube. There is a hollow cast-steel conical point at the bottom for settling into the bed of the river. There are 14 flanged diaphragm plates riveted to the shell, spaced about 5 ft. apart throughout the length of the spud, which keep the spud from buckling under a beam strain. Constructed in this manner, these steel spuds have double the strength of timber spuds of the same diameter, and are easily repaired or rebuilt in case of injury.

The spud wells are placed at the stern and constructed with heavy cast-steel hinged keepers to enable the spuds to be removed should they become bent. The dredge crew with the equipment aboard can readily replace a broken spud. Considerable trouble has been experienced by the Port of Portland by ships bumping the dredge, by shocks due to cave-ins on the ladder, thrusting the dredge back, by the action of the elements in case of storms etc. On the other dredges, designed with spuds in wells through the hull, when a spud is broken it necessitates laying up the dredge for several days and towing it to the most available sheer legs to install the new spud, entailing a loss of time and the outlay of considerable money.

The CLACKAMAS is very completely equipped to take care of her crew of 50 odd men (the number varies). The entire upper deck is given over to living accommodations, there being the officers' quarters, galley and dining room and crew's quarters. The quarters are large and roomy, every effort having been made to provide for the complete comfort of officers and men.

The dredge is now working on a 7,500-foot line with a thirty-foot net terminal lift delivering about 16,000 cubic yards of heavy sand and gravel per twenty-four-hour shift which is practically double the output of the 1,500 horsepower steam dredges working with a booster in addition to the dredge, which makes a saving of $1,500 per day for this particular class of dredging.

Performance of M. S. PERU

A distance of 409,175 nautical miles had been covered by the East Asiatic Co.'s motorship PERU up to her recent arrival at Vancouver, B. C., in July, 1925. She was commissioned on the 22nd of August, 1917. On her last passage from Copenhagen to Vancouver she made an average speed of 10.8 knots under favorable weather conditions on a daily fuel consumption af about 9.35 tons, according to the figures of L. M. Hansen, the chief engineer. From Vladivostok to Vancouver she averaged 11.4 knots with light cargo. This was a very favorable showing after running eight years, because the record of the first voyage showed an average speed of only 10.3 knots, while the average for the first nine voyages round the world was 10.66 knots.

Both California Diesel engine oil of about 35 deg. Beaumé and Borneo oil of 20 deg. Beaumé have been used. The Borneo oil direct from the well, and retaining its natural lubricants, was said to be the most satisfactory. On her last call at Denmark the PERU was equipped with two Titan centrifuges which are used for purifying the fuel oil, and Mr. Hansen expresses himself as very well pleased with the results, which he expects will give a much longer lease of life to the cylinder liners. Up to the present, these liners have had a life of about five years each, and the PERU is now working on her second set.

On the last passage lubricating oil consumption for the cylinders is said to have been 35.5 lb. in 24 hours, compared with an average of 53 lb. per 24 hr. on her first voyage, while the lowest consumption that had been experimented with was an average of 31 lb. a day. Bearings take 33.3 lb. per day, and the air compressor, uses an additional 3.3 lb. A Veritas No. 7 oil is used for general lubrication and a Vacuum oil for the compressor. PERU is a vessel 444 ft. o. a., 425 ft. b. p., 55 ft. 6 in. molded breadth, with a cargo capacity of 10,200 d.w. tons on a draft of 27 ft. 11 in. in salt water. On one voyage she carried a cargo of 9600 tons of wheat and 600 tons of iron. She has tank capacity for 1230 tons of fuel oil, sufficient for 130 days, so that a considerable surplus is available for discharge at Danish ports. Her engines are twin 6-cyl. 4-cycle B. & W. type with 2400 s. hp. The electric cargo winches are said to be giving very satisfactory service, the winches originally installed being still in service and giving very little trouble for upkeep.

Phila.-N. Y. Water Line Service

The Philadelphia Packet Line, of Philadelphia, has been incorporated to operate a line of small coastwise freighters between New York and Philadelphia and ports as far South as Florida. Package freight will be handled and it is expected that a twenty-hour service between Philadelphia and New York will be offered to shippers. Edward Rice, Jr., president of the company, recently placed an order with the New London Ship & Engine Company, of Groton, Conn., for a 450 hp. Nelesco Marine Diesel engine. This engine is to be installed in a 150-foot steel freighter, conversion plans and specifications of which are now being prepared by M. C. Furstenau, naval architect, of Philadelphia. The vessel will carry 400 to 450 tons of cargo and is equipped with a modern traveling hoist which will permit prompt unloading without the assistance of dock or ship's tackle. The use of Diesel engines in this type of ship offers an excellent opportunity to effect substantial savings in operating costs as compared to the use of steam machinery. With the employment of the economical Diesel equipment, together with the rapid handling deck apparatus, the Philadelphia Packet Line intends to offer a service which will be unique in the shipment of freight between these sister ports.

Record Halibut Schooner

From Ketchikan, Alaska, to Seattle, a distance of 651 nautical miles, is a run made by nearly all the halibut schooners of the North West at one time or another. The record for the run is reported to be held by Capt. C. O. Angell's ALASKA with a time of 65 hrs. flat. She is a boat 82 ft. 0 in. x 18 ft. 0 in. x 9 ft. 0 in., built in 1913 by Nelsen & Kelley, originally equipped with a 110 hp. gasoline engine, but now powered with a 3-cylinder 135 hp. Washington-Estep engine, turning at 280 r.p.m. and swinging a 60 in. x 51 in. wheel. Capt. Angell claims his boat can do better than 11 knots when the engine is forced.

Maiden Voyage of Ore-Carrier Svealand

From Cuxhaven, Germany, to Cruz Grande, Chile, in Ballast and Thence to Baltimore, Md., with 20,688 Tons of Ore

ON April 11 at 4:20 a. m. the ship left Cuxhaven, Germany, in ballast on her maiden passage to Chile via the Panama Canal and back to Sparrows Point, Baltimore. The machinery was working well, but owing to foggy weather full speed could not be maintained in the Channel and the ship had to slow down frequently. Lizard Point was passed on April 13, a heavy sea running and a stiff breeze blowing. When the wind eased off, some of the water ballast was pumped out in order to reduce the ship's rolling. The mean draft then was about 21 ft. and the loading condition as follows: 9000 tons water ballast, 400 tons fuel oil and 200 tons fresh water.

On April 19 the Azores were passed, and on April 30 at 9:45 p. m. the ship reached Colon. The passage from Cuxhaven to Colon, 5253 nautical miles, was covered in 20 days 20 hrs. 32 min., corresponding to an average sea speed of 11.1 knots. On some days an average speed of over 13 knots was obtained, whereas on others the mean performance was only 9 knots because the number of revolutions had to be reduced on account of rough weather.

Total fuel oil consumption for this passage was 335.7 tons for main and auxiliary engines, the main engines running all the time and the three Diesel generators for 13½ days, 4½ days, and 6½ days respectively. During the whole passage the engines worked without the slightest trouble, developing collectively about 5500 i.hp. on an average fuel oil consumption of 133 gr. or 0.293 lb. per i.hp.-hr. Vacuum D.T.E. heavy was the lubricant used.

From a set of indicator diagrams taken on April 17, the following figures are com-

	PORT ENGINE	STARBOARD ENGINE
Engine speed	114 r.p.m.	115 r.p.m.
Mean ind. press.	78.2 lb. per sq. in.	74.1 lb. per sq. in.
Maximum ind. press.	505 lb. per sq. in.	505 lb. per sq. in.
Indicated power	2886 i.hp.	2677 i.hp.
Fuel consumption	0.296 lb. per i.hp.-hr.	0.296 lb. per i.hp.-hr.

Notwithstanding the good performance of all main and auxiliary machinery, both main engines were stopped one after the other before entering the Panama Canal on the morning of May 1. The starting and fuel valves were opened up for inspection in order to avoid any possible trouble when maneuvering in the Canal.

Actually, no difficulties were met with during the transit of the Canal. When leaving the upper lock chamber at Christobal, the SVEALAND passed her sister ship STEELORE, built in 1922 by the Bethlehem Shipbuilding Co. and engined with geared turbines, on her return from Cruz Grande with a full cargo of ore. On the same day, at 5:30 p. m. Balboa was reached, and the ship having taken 400 tons of fuel oil aboard proceeded on her way. After a brief stop at the port of Arica, which had to be called at as the quarantine station, SVEALAND arrived at Cruz Grande on May 12, at 9:00 a. m. to load her cargo of iron ore.

The methods used at Cruz Grande in mining the ore and the appliances for handling it are an outstanding example of up-to-date American practice. The iron ore is obtained from open workings on a mountain about 2600 ft. above sea level and at a distance of six miles from the port. The whole mountain is one mass of iron ore containing 65 per cent of iron and formerly was owned by a French company, which transported the ore down to the bay by means of a cable railway. After the mine was taken over by the Americans, an electric serpentine railway was built.

Blasting is done on the biggest scale only, viz., by driving tunnels and galleries into the mountain and filling them with gunpowder, which breaks up the rock better than high explosives would do. As much as 100 tons of gunpowder are used at a time, and a single blasting sets the shovels working for months. The blasted rock is loaded into dump cars by means of huge grabs of 15 tons capacity each, and transported to a mill where it is broken into pieces of about two inches screen. The train taking the ore down to the port usually consists of an electric engine of 130 tons weight and 16 freight cars loaded with 50 tons of ore each. When going downhill the locomotive delivers back into the electric system nearly as much current as is necessary to take the empty train back uphill.

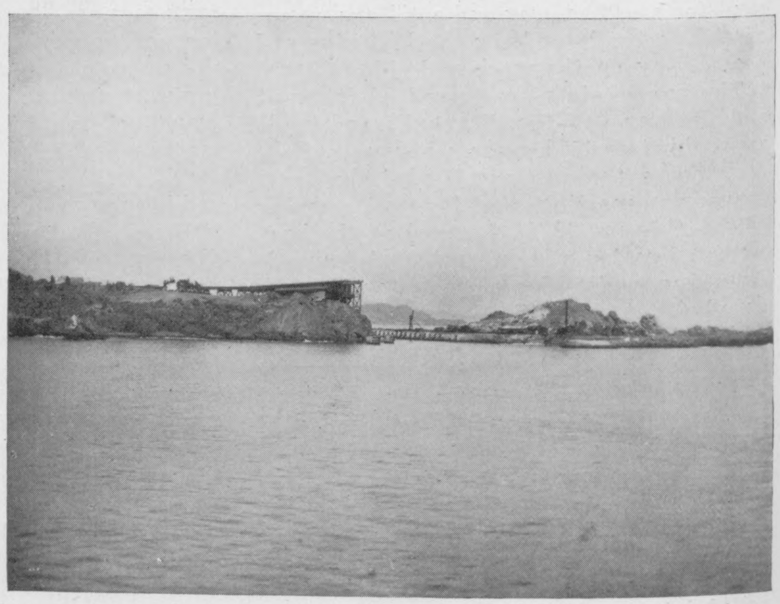
The harbor basin of Cruz Grande has been excavated by blowing up the solid rock to a depth of 40 ft., and bins have been built of 30,000 tons storage capacity, into which the 800 tons of ore from the train are discharged within four minutes. The spouts through which the bins are emptied into the ship are 16 in number and are suspended from as many separate steel bands. They can be lowered and hoisted quickly by means of electrical winches. The sliding bottoms of the bins are actuated by hydraulic power to avoid failures.

When the SVEALAND arrived at Cruz Grande, another ore steamer had just been loaded and ore had not been supplied to the bins at the usual rate, a vein of stone having been struck in the mine. SVEALAND, therefore, had to wait for her cargo until May 19, when she was berthed at the quay at 8:30 a. m. By 10:45 a. m. she had taken her full cargo of 20,688 tons of ore, and she sailed at 12:15 on the same day. The net loading time, i. e., not counting the time necessary to move the ship under the spouts, was only 49 minutes.

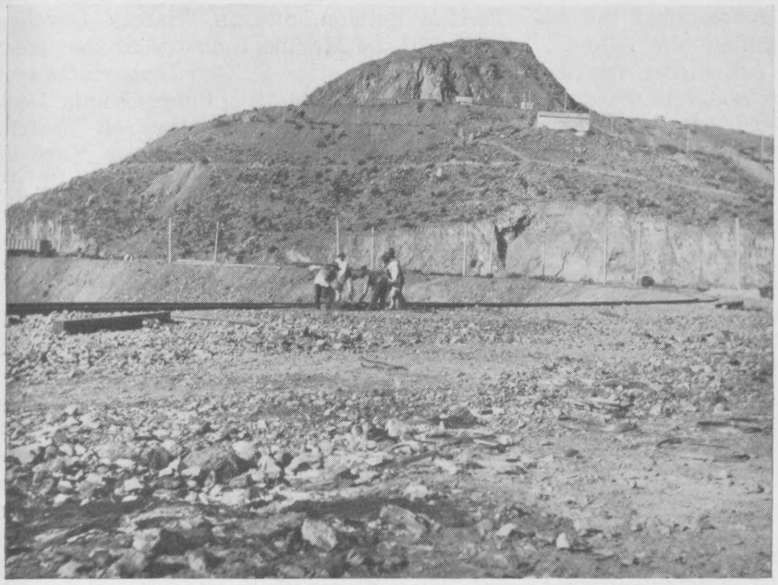
The mooring winches worked without giving trouble, automatically paying out and hauling in the lengths of rope necessary to follow the slight movement of the ship due to the swell.

When leaving Cruz Grande, the ship's draft was 32 ft. 6 in. forward and 33 ft. 6 in. aft. The loading condition was: fuel oil, 495 tons; fresh water, 60 tons; provi-

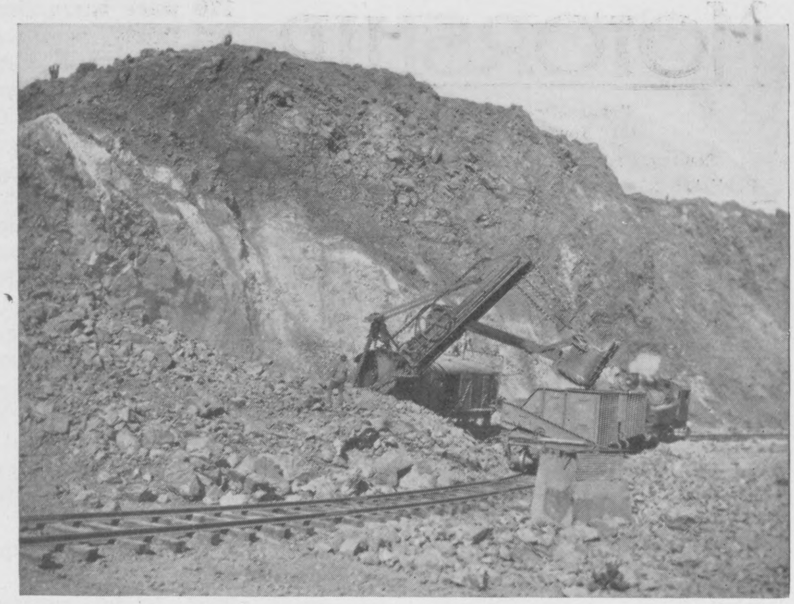
Svealand loading at Cruz Grande. Another ship waiting



General view of ore-loading berth at Cruz Grande



The mountain of iron ore and railroad down it



Electric shovel filling ore cars after a blast

sions, 25 tons; stores, 300 tons; cargo, 21,568 tons. In this condition an average speed of 11.6 knots was maintained during the passage from Cruz Grande to Balboa, with the engines developing 6010 i.hp. at 112½ revs. per min. on a fuel oil consumption, including auxiliaries, of 133 gr. or 0.293 lb. per i.hp.-hr.

Panama was reached on May 28, at 12:15 p. m. Having passed through the first of the locks the ship waited till the next morning in order to avoid meeting within the narrow zones of the Canal ships coming from the opposite direction. At 7:00 a. m. on May 29, SVEALAND proceeded on her voyage, having taken aboard several officials of the Canal Commission to test the ship's steering qualities, which they found to be thoroughly satisfactory. The assistance of the tug-boat which, at the request of the Canal Authorities and by way of precaution, had to follow the ship till the narrow zones were passed, was not required and SVEALAND was granted permission to make her further transits through the Canal in a loaded condition without the assistance of tugs, whereas for the steam driven sister ships such assistance has been made obligatory. The last lock chamber on the Atlantic side was passed at 12:30 p. m., and at 1:30 the ship sailed from Colon.

SVEALAND behaved very well in a loaded condition, the almost complete absence of rolling when she was exposed to cross seas being noticeable. The average performance was: i.hp., 6100; revs. per min., 112 to 114; speed, 11.6 knots, as compared with 11.5 knots on 6600 i.hp. guaranteed.

The temperature of the engine room when passing through the tropics was remarkably low—a fact common to motorships in particular, and due to the rapid and thorough ventilation caused by the working of the main engines. The highest temperature recorded in the engine room was only 95 deg. Fahr. The exceptionally low fuel rate of only 3.2 gr. per ton of cargo per mile run is worth mentioning, being probably the lowest fuel rate at which cargo was ever transported.

SVEALAND arrived at Sparrows Point on June 5 at 6:00 p. m. and made fast to the pier of the Bethlehem Steel Works.

During the voyage from Cuxhaven to Sparrows Point, a distance of nearly 12,500 nautical miles, no trouble was experienced with main or auxiliary machinery. The necessary inspections were easily carried out by the engine room staff with the means available on board ship. That the ship was able, immediately after the maiden voyage of two months and a stay in port of only 24 hours, to start on her second trip is the best proof of the reliability and efficiency of the machinery installed and of the competency of her engine room staff.

World Largest Motor Liner

New 21¾ Knot Vessel for the N.G.I. Will Have 32,000 Tons Displacement and 28,000 S.hp.

REVISED particulars of the big passenger motorliner ordered by the Navigazione Generale Italiana show that the vessel will be in every way the world's leading motorship. Her tonnage is now given at a higher figure than before, but the speed is quoted lower. A new name is also given to her, the third which has been published.

The figures, as now given, are shown below, but are to be accept as subject to change:

Length o.a.	706 ft. 0 in.
Length b.p.	664 ft. 0 in.
Breadth molded	82 ft. 6 in.
Depth, molded to D deck at side	51 ft. 5 in.
Deadweight capacity on 30 ft. draft,	10,500 tons
Displacement on 30 ft. draft	32,000 tons
Sea speed	21¾ knots
Engine power	25,000 s.hp.

AUGUSTUS, as the vessel will be named, has about the same dimensions as the s.s. ROMA building for the same company. Her internal arrangements will, however, be quite different. The drawings show that she will have a straight stem and an elliptical counter. She will be of the awning deck type, with a long bridge house containing promenade deck and boat deck. Below the awning deck there will be two continuous decks, the upper deck and the main deck, and below the latter there will be a lower deck extending fore and aft from the engineroom bulkheads. There will be 11 water tight compartments, with 10 water tight bulkheads, designed in accordance with the usual practice for two compartments flooded. Some of the hold space will be insulated for a refrigerated cargo of fruit, meat or agricultural products.

AUGUSTUS will be a quadruple screw motorship, and her propelling machinery will consist of 4 sets of double acting 6-cylinder 2-cycle Diesel engines. The machinery has been ordered from the Cantieri Officine Savoia, an associated firm of the Ansaldo Company which is building the ship. The four main engines will have cylinders with a diameter of 27.56 in. and a stroke of 47.24 in. The normal service speed will be 120 r.p.m., and at that speed the engines will develop in the aggregate 25,000 s.hp., but the engines will be arranged to turn up to a speed of 125 r.p.m., giving them a maximum of 28,000 s.hp. These engines will be of the M.A.N. design illustrated in MOTORSHIP last year.

The vessel will have three electric generating sets of 600 kw. driven by 6-cylinder engines of 900 s.hp. at 215 r.p.m., and there will be also five generating sets of 280 kw. driven by engines of 425 s.hp. at 300 r.p.m. The total power of Diesel engines aboard the vessel will therefore be 29,825 b.hp. in normal service, with a possible maximum of substantially 33,000 s.hp.

It is stated that the weight of the main engines is 800 tons less than that of the double acting 4-cycle engines offered for the same installation.

Motor Tug for Valparaiso

A single screw eighty-six feet motor tug and water tender named TEMUCO and propelled by a 100 b.hp. oil engine has been built in three sections for shipment to Valparaiso by Harland & Wolff for the Pacific Steam Navigation Company. The TEMUCO ran trials on September 3. Her electric-driven fresh water pump can put 100 tons per hour into her 150 ton tanks.

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Still in the 1918 Class in U-Boat Oil Engine Development

NO orders have been placed with American Diesel engine builders for submarine engines since the international naval agreement and the enforcement of the drastic economy program of the executive government, nor have they been given any encouragement by our Navy Department to develop further the high-speed lightweight type of high-powered oil engine needed for modern submersible ships of our defense line. What work of this nature that has been done has been limited to modifications in one of our Navy yards of the German U-boat engine of Class 1918, while the facilities of certain private American establishments, once almost entirely devoted to naval output, have been turned over to commercial production exclusively.

Regardless of the great advances made in aircraft engineering, an enemy's submarine fleet driven by its long-distance cruising Diesel engines will always be lurking unseen to sink aircraft carriers. With our tremendous shore line to guard, submarine engine development in this country should be carried on to the point of great advancement over any other nation, instead of continuing with past practice and always remaining behind.

Colonel William Mitchell, of aircraft service denunciation fame, in his new book, "Winged Defence," gives a timely warning of the danger America is facing, and emphasizes the unequalled effectiveness of the submarine as a weapon for both defense and attack. He cites figures to show that in the World War Germany never maintained more than thirty submarines at sea at one time. It built about 430 U-boats, of which 146 were sunk and 170 were surrendered after the armistice, but thirty, he insists, represented the active force operating against the Allies.

The whole German submarine service, he adds, was handled by about 10,000 men, but "the Allies employed over a million men in an attempt to counteract these thirty vessels." The U-boats sank 11,153,506 tons of allied shipping, including about forty per cent of Great Britain's total merchant marine.

They destroyed the battleship AUDACIOUS, the cruisers HAMPSHIRE, CRESSY, ABOUKIR and HOGUE, and perhaps two other battleships in the Dardanelles; kept whole fleets locked up in harbors when not zigzagging at great speed for a few hours on the high seas, crossed the Atlantic and brought England to the verge of starvation.

"The surface ship, as a means of making war," he declares, "will gradually disappear, to be replaced by submarines that will act as transports for air forces and destroyers of commerce."

Accident Prevention and Safety

AFTER an uphill fight to get things going, the Marine Section of the National Safety Council is beginning to gain real support from shipowners and stevedoring companies. At the Convention in Cleveland, O., the Marine Section listened to four excellent papers.

"I was astounded at the amount of money these actions were costing shipowners and shocked at the maimed condition of some of the plaintiffs" was one of the opening sentences in a paper on "Marine Safety—Some Present Day Perils," read by Mr. Henriques, marine valuation engineer of New York City. "To give you an idea as to the price of this carelessness I will take at random 12 cases in which I appeared, where the verdicts and costs amounted to $244,750, which is an average of something over $20,000 per ship," he stated.

A number of instances of preventable accidents were cited by the author who strove to show that shipping would be relieved of part of its burden if safety engineers were employed to educate men about the perils they face in their daily work, which they either ignore or will not trouble to remove. Mr. Henriques suggested that safety surveys should be made aboard ships by qualified men of experience.

In an address entitled "A Year's Attack on Stevedoring Accidents on Puget Sound," Mr. Arkiss, safety engineer of the Water Front Employers of Seattle, reported the results of the first year's safety activities at that port. He related the work that had been done and enumerated the items to which attention had been given in the preventive work. It is just a year ago since the longshoremen, truckmen and water front employers of Seattle began an organized attack on stevedoring accidents. The last half of the year's work shows a considerable reduction in the causes of accidents that headed the list during the first half year and indicates therefore that the work of the safety engineer has been helpful. Men and machinery were responsible for the actions in about equal proportions. By educating the men and by encouraging the more careful and frequent inspection of machinery a number of accidents can be greatly reduced.

Two other papers were read before the Marine Section, one on "Safety Developments in the Marine Industry of the Great Lakes" by Charles E. Cole, superintendent of the Ohio & Western Pennsylvania Dock Co., Cleveland, and the other on "Safety Organization in the U. S. Navy Yard at New York City" by Lieut. Comm. R. P. Hinrichs, U. S. N.

A Busy Oil Engine Industry

THE steadily improving business conditions throughout the country are having favorable reaction on oil engine builders. Not all—but by far the majority of oil engine builders have been enjoying unusually busy times, and even importers of European engines have lately found a big jump in their sales. Two and three shifts per day are to be found in several plants, and nearly all firms are working to capacity. Especially is this the case with companies whose models include a size of engine suitable for tugs, dredges, ferries and other work boats.

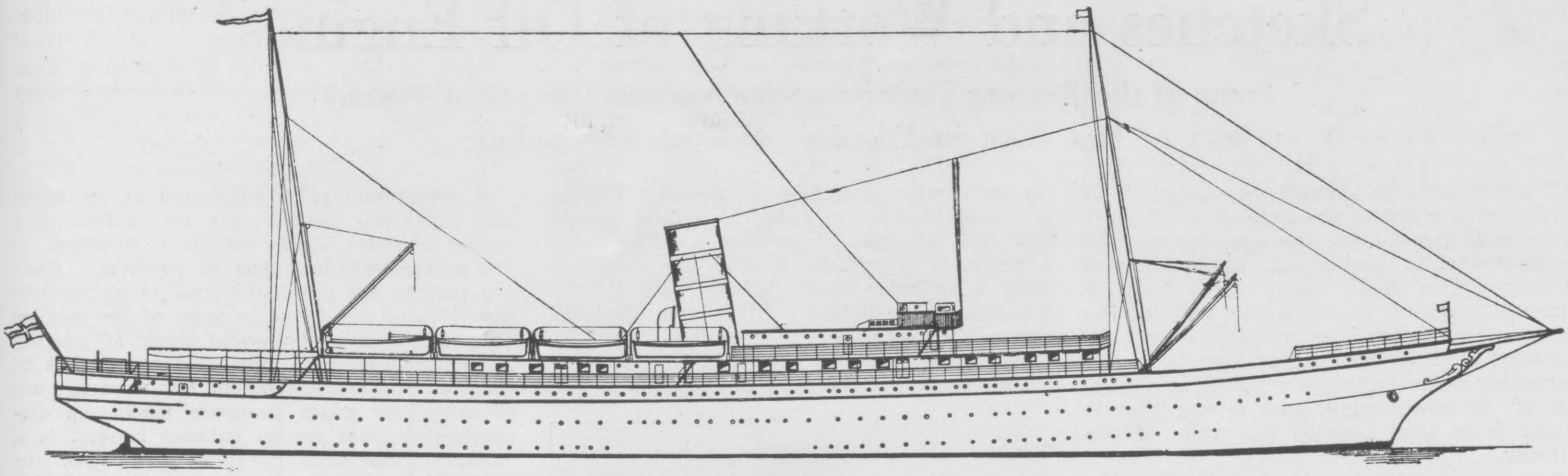
The total horsepower now being delivered each month is greater than ever known in the history of the Diesel engine, and one Wisconsin factory alone will have produced 300,000 horsepower by the end of the year, with sales value of about $18,000,000. A member of our staff who has just returned from the Middle West reports every oil-engine factory unusually busy and their sales organizations very optimistic over the coming year. One firm who hitherto has devoted its large output almost exclusively to stationary power units finds its marine business shooting ahead of the land orders, yet the stationary business is producing more wrok than ever before.

A Creditable Job

THE story of the Port of Portland dredge printed in this issue of MOTORSHIP is such as to arouse a feeling not unlike exultation over a big achievement daringly conceived and brilliantly executed.

Outstanding among the many significant features of the big dredge is the fact that it was designed and built around the idea of using Diesel engines. There was no jockeying with specifications, no dickering with engine manufacturers about this or that design detail. In fact practically one half of the engines were bought at a special opportunity offering itself when the U. S. Shipping Board disposed of some of its unused propelling machinery. Good engines were available at a favorable price and they were soon to be needed for equipping a dredge: that was all the information the Port of Portland authorities had to have in order to go ahead. There is a touch of Western freshness and wholesome single-mindedness about their procedure.

Apparently the same spirit was carried through in the work of constructing and equipping the dredge. Although lavishness and needless expense has apparently been avoided, there can also be little doubt that the man responsible for the entire design knew what was necessary and got it. As far as can be judged, the work bears all the marks of having been done by one who had a large freedom of choice as to methods and equipment and who used his freedom with a full sense of responsibility guided by expert knowledge.



View of Norwegian Shipping Company's new motorship for ocean cruises

Passenger Motorship for Ocean Cruises

Luxurious Vessel for 300 Passengers Ordered by Norwegian Shipping Company for Extended Cruises

TO attract patronage for its cruises to various ports of Europe and to the Mediterranean, Det Bergenske Dampskibs-selskab of Bergen, Norway, has just ordered a yachty-looking motorship of about 6000 tons displacement and a speed of about 15 knots. The owners are running a similar ship, the METEOR, built in Hamburg in 1904, which was once considered to have very spacious accommodation. The new ship is about 50 per cent bigger: METEOR carries only 200 passengers, while the new vessel will have accommodation for 300 passengers.

The new motorship will be the biggest vessel of her type in service. With a clipper bow, graceful sheer, long counter and schooner rig the new cruising motorship has the lines of the old steam yachts that were modeled after the beautiful sailing vessels of the fifties and sixties. Her accommodation will be in harmony with her yachtlike appearance and will be luxurious and commodious. All the passenger cabins will be furnished with beds instead of with berths and will be arranged either for the accommodation of single passengers or for two passengers and nearly all the rooms will have private bathrooms attached. There will be also four suites de luxe. The dining room, which will be on the main deck, will have a floor area of about 3500 sq. ft. Music room, writing room and smoking room, which will all be on the bridge deck, are also generously proportioned. The leading dimensions of the new vessel are—

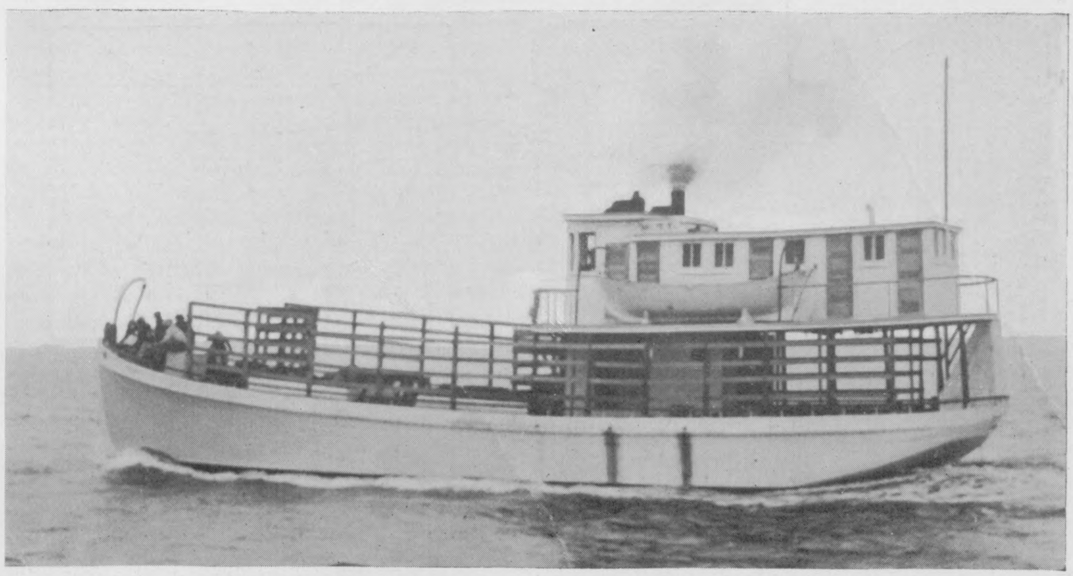
Length o.a.	428 ft. 0 in.
Length on water line	360 ft. 0 in.
Breadth molded	50 ft. 6 in.
Depth to bridge deck	38 ft. 6 in.
Gross register	about 5200 tons
Displacement on 17′6″ draft	about 6000 tons

The propelling machinery will consist of two Götaverken engines giving about 3900 s.hp. aggregate and driving the vessel at about 15 knots. All auxiliary machinery on deck and in the engine room will be electrically driven, and electricity will also be used to a considerable extent for cooking. The order has been entrusted to the A/B Götaverken, the leading Swedish shipyard, which has been one of the world's biggest builders of motorvessels. Delivery will take place about March, 1927.

In an article dealing with a passenger cruising motorship in our December, 1924, issue some of the advantages which Diesel power presents over steam in such service were brought out in a very striking manner. It was there shown that whereas a turbine steamer would not make a profit unless her capacity were used to the extent of 75 per cent, a motorship would make a profit even if only 60 per cent of her capacity were sold. With 90 per cent of her capacity booked, the motorship would earn net about 15 per cent on her capital costs, while the steamer would give less than 9 per cent. Such considerations explain the decision of Det Bergenske Dampskibsselskab in selecting Diesel engines for the propulsion of its new cruising ship.

Mutt and Jeff

Col. A. Phillips, of the Phillips Packing Company, Cambridge, Md., has what he calls two "real" boats in MUTT and JEFF, which each carry about 150 tons. They are used for transporting tomatoes from New Jersey and the Philadelphia markets in some seasons of the year and supplies from other sections to the company's plants. The illustration of the MUTT on this page shows her on her way to load a cargo of tomatoes, with the racks in place that enable her to carry the tomatoes without mashing. Each of the boats has a 60 hp. Fairbanks Morse engine, and the cost of fuel and lubricating oil for the round trip from Cambridge, Md., to Philadelphia and return, a distance of 340 miles, is less than $20. The *New York Commercial* reported last year a race between them from Cambridge, Md., to New York with a cargo of the new pack of Early June Peas, which Colonel Phillips carefully explained was of his Castle Haven Brand. MUTT and JEFF left within a cable's length of each other and arrived at the end of their passage within three cables' length of each other. It looked like a close race, but, however that may be, there is keen rivalry between the two captains, and the company is glad of it.



Mutt, the oil-engined tomato carrier

Sketches and Working of Oil Engines*

Some of the Reasons Underlying the Various Designs of Pistons Met With in Practice; Methods of Cooling

IT would seem as though the piston of an oil engine is one of the simplest parts on it and should give neither the operator nor the designer much to think about. It appears also as though this should apply particularly to crosshead engines, in which the body of the piston is little more than an inert plug fully protected against the angular thrusts of the connecting rod and effectively guided by the action of the crosshead in such a way that it hardly more than touches the walls of the cylinder.

As was pointed out in the last chapter, the piston gathers on its crown the gas pressure which is built up in the combustion space of the engine, a total force which in many cases exceeds 100 tons. At the same time the crown is exposed to the heat of combustion amounting to more than 2,500 deg. F. at the center of the gas volume. As is the case with the cylinder walls, the piston crown probably falls far short of acquiring any such temperature as this; nevertheless, the heat and the force together make a rather formidable combination. Few pistons of a size sufficient to justify the use of a crosshead can run without being cooled by a circulation of water or oil, and with the presence of a cool fluid inside of the piston and of heated gases on the outside the condition of the cylinder head and walls is parallel.

Cast-iron has been most widely used as the material for making pistons because of its ability to withstand mechanical stress while being subjected to high temperatures. Forged steel has also been employed in some cases, but its great expense coupled with its smaller resistance to corrosion have militated against a far-reaching adoption of this metal. Steel, of course, has an advantage which cast iron does not possess in so great a degree; corresponding to its greater mechanical strength the pistons made of it can be built lighter and are commensurately better cooled.

Owing to its close proximity to the cylinder wall and its consequently rather complete protection against the fire of combustion, the circumferential wall of a piston is not so severely taxed, and the secret of success appears to lie in getting the crown to stand up under the conditions of service. Pistons are made hollow in order to reduce weight and save material; from that it follows that a piston is essentially a drum-like structure with a cylinder shell, bottom, and a diaphragm corresponding to the crown stretched across the top of it.

A typical piston is shown in Fig. 83 with a cross section of the same reproducted in Fig. 84B. The drum-like structure as well as the diaphragm forming the piston crown are clearly depicted there. It is to be noted that as there is no central support for the crown all the stress which it picks up from the gases must be transmitted out to the edges by the metal which it contains.

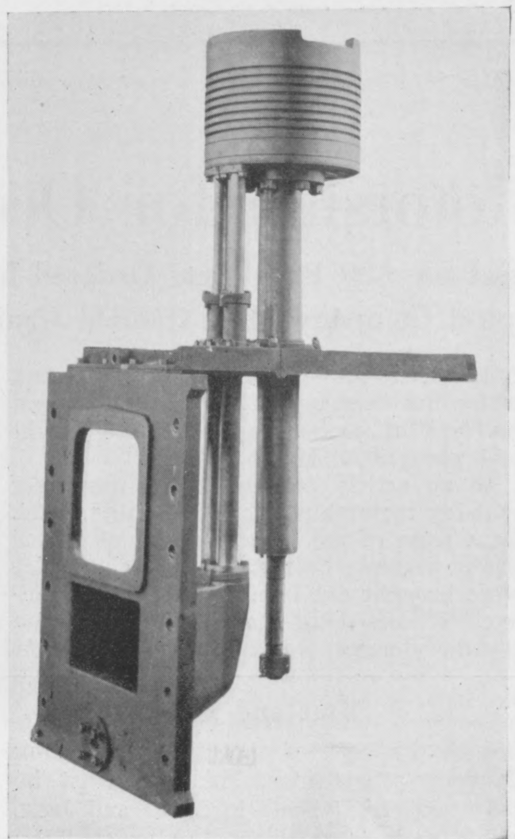


Fig. 83. Piston with cooling tubes

A flat round plate supported at its edges and uniformly loaded over its surface is a rather complex static structure ill-suited to the service which it has to perform. Flat-top pistons are quite universal in automobile practice and are found in some of the smaller oil engines. No one would think of putting a flat head on a cylindrical tank subject to pressure without staying it, but even the use of stays for plain pressure tanks, as distinguished from return tubular boilers, is a rarity. Tank ends are either "bumped" or "dished" in the great majority of cases, and by the same general reasoning practically all oil engine piston crowns are made either convex or concave. Bulging or "bumped" pistons are perhaps less frequently encountered because of the less favorable shape which they give to the combustion space.

A person's mechanical sense would tell him that almost any shape rather than a flat one would be better for resisting the pressure on the piston crown and it would not be difficult to back this up with a mathematical demonstration. It is perhaps easiest to bear in mind that the elastic shape into which a ductile flat plate would be deformed under pressure is also the one which would have made a stronger structure in the first place. In the rubber diaphragm analogy shown in Fig. 85A the effect of the pressure on the originally plane surface is indicated. As we know that the flexible material is incapable of taking any bending stress, that is, of acting like a bridge, every part of the outline marked "Flexible Diaphragm" must be subject to pure tension only. In the same way the dishing of a piston crown relieves it of the worst bending stresses and makes it subject to more nearly pure tension, a type of stress which cast iron is better able to resist than bending. A still further easing off of the stress is obtained by placing a support as indicated in the diagram; but as will be apparent shortly, this latter is an expedient of doubtful value when applied to the pistons of oil engines.

In Fig. 84A is shown a hollow cast iron piston bolted to the flanged end of a piston rod, on which it is secured by studs at *f*. Most of the load coming on the crown *a* is intended to be transmitted through the circumferential shell *e*, but the designer did what would appear to be perfectly logical in attempting to give the crown additional

* Summary of a course of instruction at the Polytechnic Institute, Brooklyn, N. Y., by Julius Kuttner, B. Sc. Licensed Chief Engineer, Editor of OIL ENGINE POWER and Associate Editor of MOTORSHIP. This is the ninth chapter, the first one having appeared in the January, 1925, issue.

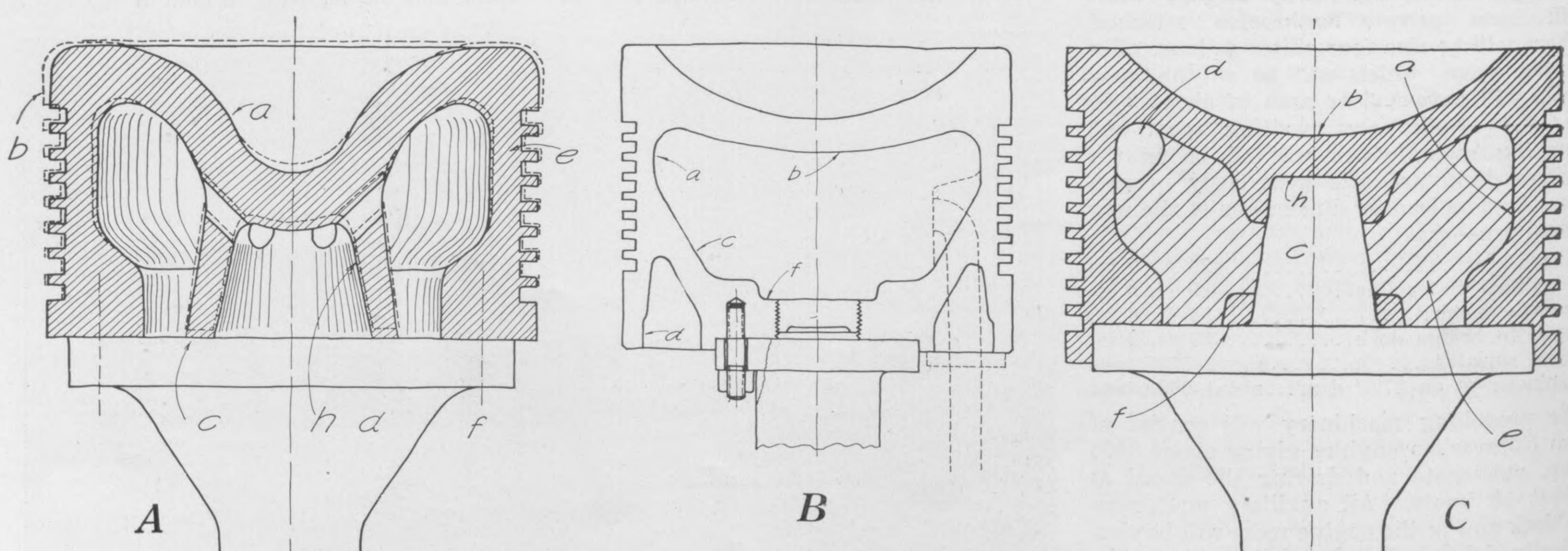


Fig. 84. Various piston designs

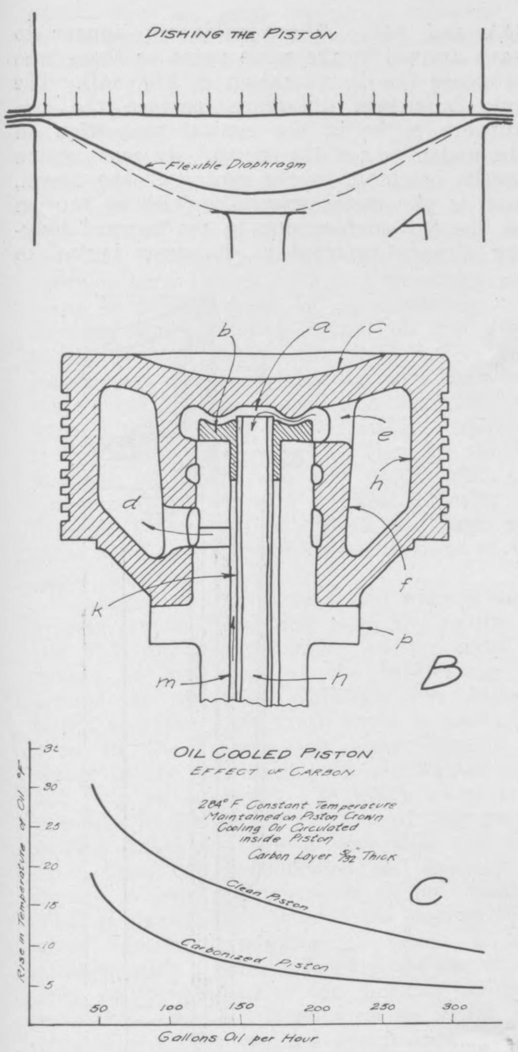


Fig. 85. A—diaphragm analogy; B—Special design; C—heat transfer

support by means of the hollow conical surface *h*.

Experience had already at that time shown that it was necessary to turn a good deal off the outside diameter near the upper edge of the piston in order to prevent it from seizing the cylinder as the result of expansion due to heat. But the matter had apparently not been thought out to the extent of picturing the entire piston as being distorted by the very considerably increased dimensions of the crown *a*. As this part grows in all directions it undoubtedly takes with it the outer piston shell as indicated by the dotted outline at *b* and unmistakably brought home by the large amount which had to be turned off the diameter at this point. But it would be impossible to imagine all this happening to the upper part of the piston without some effect being produced on the conical support *h*. It must undoubtedly have been lifted off the flange as indicated at *c* and have lost its supporting power altogether.

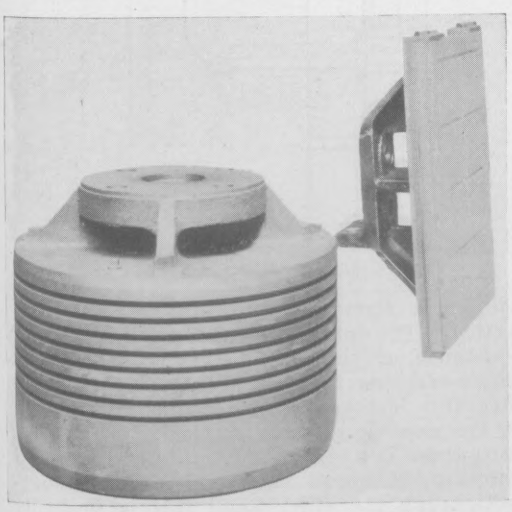


Fig. 86. Piston with bolting flanges

A piston with a central support *c* forged on the end of the piston rod and with radial bracing webs *e* is shown in Fig. 84C. Near the bottom the webs are joined by the central ring *f* and near the tops they are broken through by the holes *d*. Like the type of piston discussed above, stress transmission was to take place through the shell *a* as well as through the central support. In addition, the webs were to make a rigid structure of the entire piston and were to eliminate cracking by "brute force and awkwardness." In spite of everything, however, support was lost at *h* and the design was discarded.

Realizing the futility of attempting to support the crown both at its circumference and at its center, the designer of the piston shown in Fig. 88 transmits the load only by means of the internal webbing *b*. As clearance is provided at *d*, the shell *a* is free to yield to the distortion of the crown *j* without cramping the main body of the piston. It is not altogether certain, however, that this has completely solved the problem, as breakages of this general type of piston have been reported. It is not always easy to tell whether failures are due to the structures or to defects in the operation of the piston cooling system.

An even more thoroughgoing attempt to insure piston success by giving almost unlimited rigidity to its structure is embodied by the one shown photographically in Fig. 86. As will be apparent from a cross-sectional view of the same general design reproduced in Fig. 87, there are six heavy webs arranged radially to meet a cone closed all around except for 90 deg. of its circumference. Apparently neither the crown nor the shell can expand without tearing away from something, as seems to be borne out by the fact that all six pistons on one engine which were cast according to this design failed within a relatively short period of operation. One good feature seems to be the provision of an exterior bolting flange, which allows through bolts to be used in connecting the piston rod, the studs being eliminated. Withdrawal of the piston is easily effected.

For pistons of moderate diameter the design in Fig. 85B may be regarded as suitable, although the conflicting supports *f* and *h* are found in it as in Figs. 84A and 84C. The piston is well centered and aligned on a forged spigot of the piston rod, the load being transmitted to the flange *p*. Distortion of the crown should not, however, be as pronounced as in some of the types previously discussed because of the provision of active cooling water circulation at *a*. There is still an opportunity for cracks to be produced owing to the difference in expansion between the inner and outer walls *f* and *h*, respectively. It is probably an open question whether most of the strains originate in this feature or whether they are attributable almost entirely to the distortion of the crown. If the latter is the case and if the intensive water cooling indicated in Fig. 85B fully serves its purpose in sufficiently reducing the temperature of the piston crown, it is not impossible that this design may offer a complete solution.

A laudable attempt to give the piston crown support over its entire extent is illustrated in Fig. 89A where concentric circular webs are shown resting directly on the flanged end of the piston rod. As it would naturally be unwise to join the two together by any form of screwed fastening, an auxiliary ring or drum *a* is employed for this purpose. The latter is urged against the lower edge of the piston shell by means of studs, but is prevented from touching it by a slight clearance. The actual force of the studs is exerted at the upper edge of the auxiliary drum, at the point where it makes contact with the under side of the flange. As a consequence of this the flange is pinched and held between the rim of the drum and the machined ends of the circular webs.

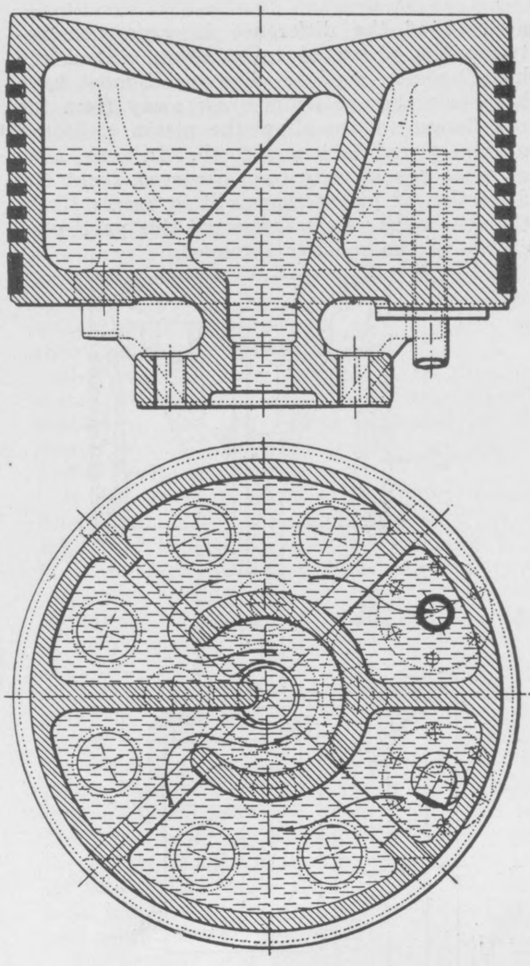


Fig. 87. Cross-sections of piston like fig. 86

In the absence of data concerning the operation of this design nothing definite can be said about it except that it was quickly superseded by an arrangement to be considered shortly. There appears to be little doubt, however, that the piston mounting shown in Fig. 89A proved unsatisfactory on

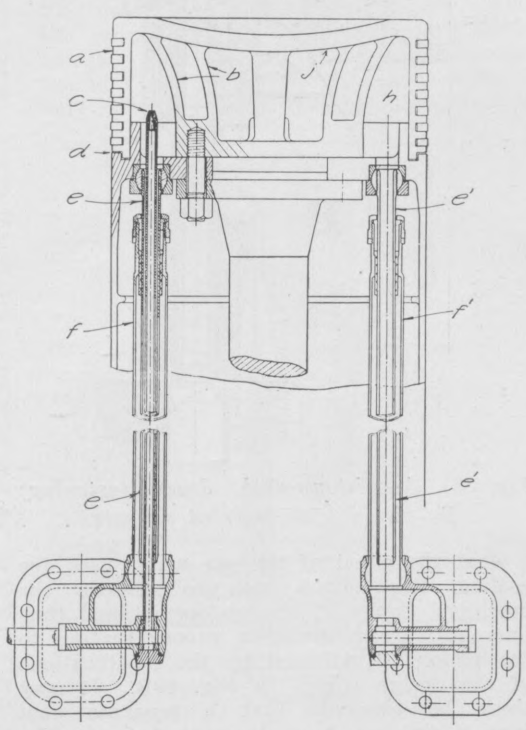


Fig. 88. Piston with central crown support consisting of webs

account of the difference in expansion between the protected inner drum *a* and the heated piston shell *b*. The result must have been to make the drum draw away from the rod flange and to allow the piston to loosen up and pound back and forth. In view, also, of what has already been observed about the distortion of piston crowns it is hardly likely that the webs really supported this particular crown in the manner intended.

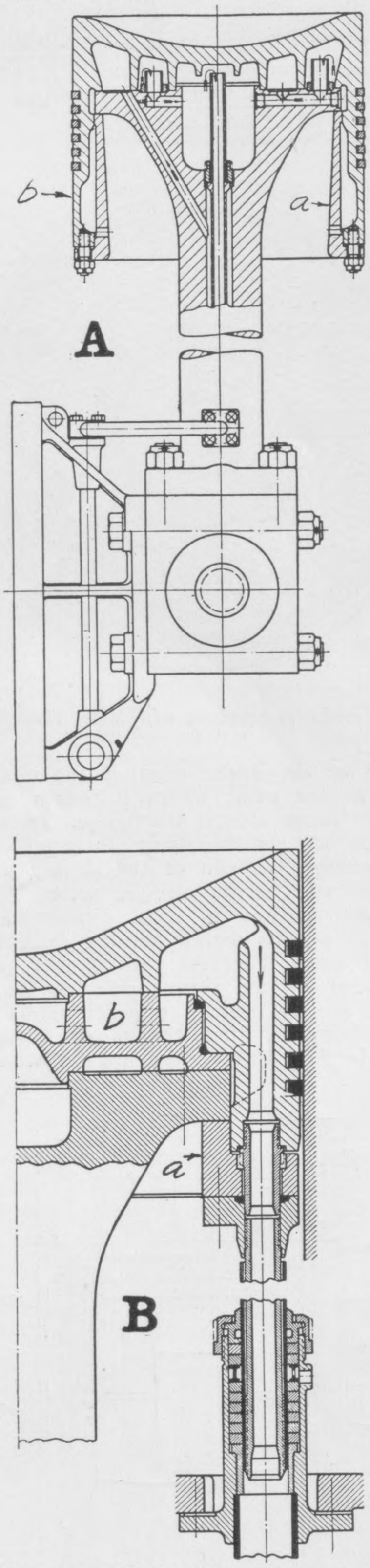


Fig. 89. *A—piston with drum fastening; B—piston with inserted support*

That the effect of the sea water used for cooling this piston was to corrode the machined flange of the piston rod and thus prevent it from giving a proper seating to the piston is indicated by the modifications of the design shown in Fig. 89B. It may there be observed that a separate cast iron piece has been inserted between the piston and the rod, probably for preventing the sea water from touching any machined steel surfaces. Two rubber packings are

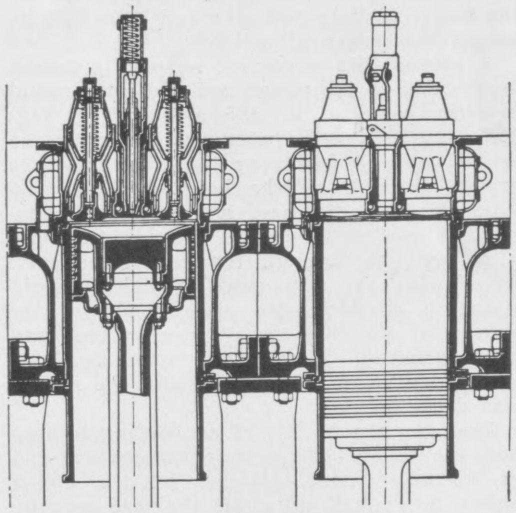


Fig. 90. *Solid plug piston*

used to make a water-tight chamber of the cast distance piece and the body of the piston. It is apparent also that troubles possibly arising from unequal expansion are more carefully guarded against than in the preceding design by a material shortening of the ring *a*.

An unusually interesting way of getting satisfaction out of a piston is illustrated in Fig. 90. In this design there is no such thing as a crown in the ordinary sense of the word as it has been largely replaced by a solid metal plug which looks as though it would need an exceptionally large amount of ill-treatment to make it fail. For practical purposes the shell of the piston may be regarded as double-walled with the inner wall having a shoulder to support the plug and acting as the stress transmitter. As the outer wall is closed off by a slideably jointed ring, it cannot carry any thrust and cannot be cramped by unequal expansion. The ring which is flanged to it and which retains the cooling water is packed against the central body of the piston by means of the same type of rubber joint as that used on cylinder liners and described in an earlier chapter.

After considering all these methods of attacking piston problems one is tempted to refer back to the more straightforward design illustrated in Figs. 83 and 84B. In the long run it appears best not to encumber the piston crown with any attempts to give it support. Leaving the under surface free for the unobstructed transmission of heat appears to produce better results.

Another engineering firm which seems now to be of this opinion is represented by the piston shown in Fig. 91, which was evolved out of the older designs sketched in Figs.

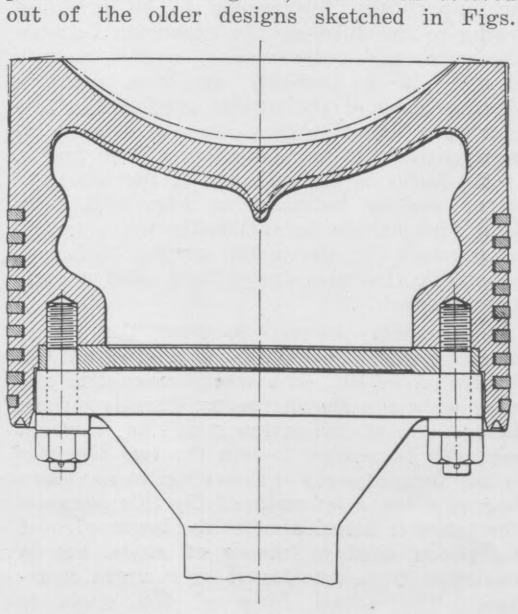


Fig. 91. *Conical projection on piston crown*

84A and 84C. These engineers appear to have arrived at the same point as those who produced the design shown in Fig. 84B. The only important difference between the two appears to be in the conical projection on the under side of the crown. As most piston cracks originate in the center of the crown, and as the metal generally fails by tension on the top surface due to the upward bulging already referred to, it seems logical to

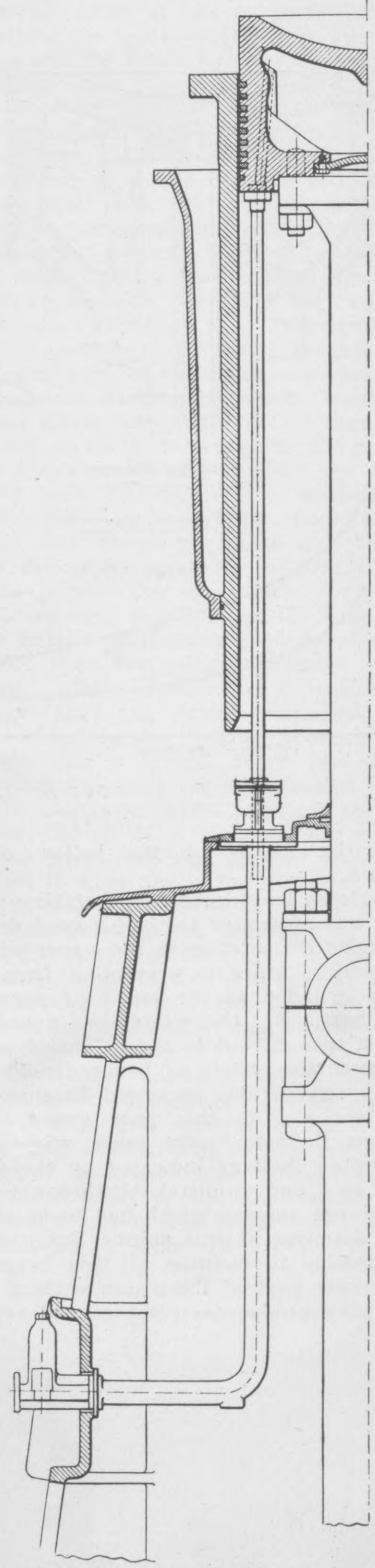


Fig. 92. *Arrangement of cooling tubes with exterior packing*

add extra strength as is done by the projection. The latter increases the moment of resistance of the section just at the point where cracking is likely to start; at the same time this increase in strength is not bought at the expense of heat transmission. To be sure, there is a slight thickening of the metal immediately above the center of the projection; on the other hand this is probably compensated for by the increased superficial area of metal exposed to the action of the cooling medium.

Whatever the internal structure of a large piston may be, good cooling is essential to its success. Although air cooling suffices for pistons of smaller diameter, the circulation of some fluid through the moving piston becomes unavoidable after a certain diameter is exceeded.

The two major mechanical considerations underlying all piston cooling arrangements are that the piston reciprocates at a fairly high velocity (around 800 ft. per min.) and that its relatively large clearance in the cylinder bore (about 1/32 in.) generally prevents it from moving in an absolutely true straight line. Sliding tubes, on the other hand, through which the fluid enters and leaves have a diameter hardly more than one-tenth that of the piston and therefore require a considerably smaller sliding clearance if they are to remain tight. They are slender and can be firmly held only at one end, circumstances which add to the difficulty of keeping them in line. Both packings and tubes tend to wear quickly on account of the rapid motion.

Leakage due to clearance and wear is more or less serious depending upon the nature of the fluid used. Salt water leakage must of course be kept out of the lubricating oil system at all cost, although the damage is not so great when fresh water is used; but even in the latter case accumulations of water in the lubricating oil circulation cannot long be tolerated. In many cases it is possible to locate the glands of the piston cooling tubes in such a way that the drip from them can be collected and drained off before it can get where it is not wanted. That is particularly true in the case of four-cycle crosshead engines in which a diaphragm with a stuffing box for the piston rod may be located under the working cylinder in such a way that it seals off the crank and crosshead spaces against every kind of drip coming from above.

The advantage of using lubricating oil for piston cooling lies in the fact that any amount of leakage less than that which will drop the pressure in the system is of no particular consequence. The objection to its use in its low specific heat (only about one-half that of water), in the need of condenser-like apparatus for cooling back the oil, and in the deposit of carbon from the oil sometimes occurring on the under side of the piston crown.

The use of fresh water, although favored by a number of builders, is regarded by others as a half-way measure, particularly in view of the troubles sometimes experienced on shipboard in keeping down the salinity of so-called fresh water. The latter must also be cooled back in the same way as the lubricating oil and requires the maintenance of the same auxiliary equipment.

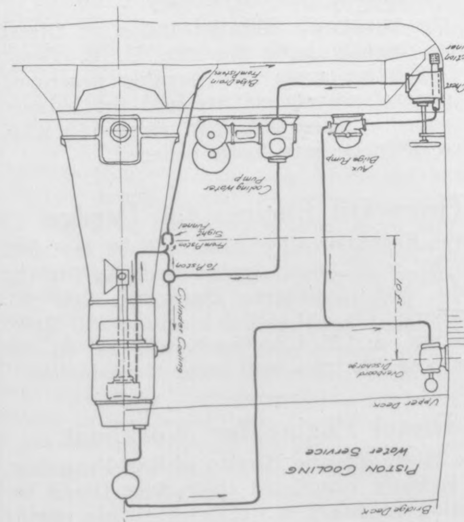


Fig. 93. Piston cooling circulation system

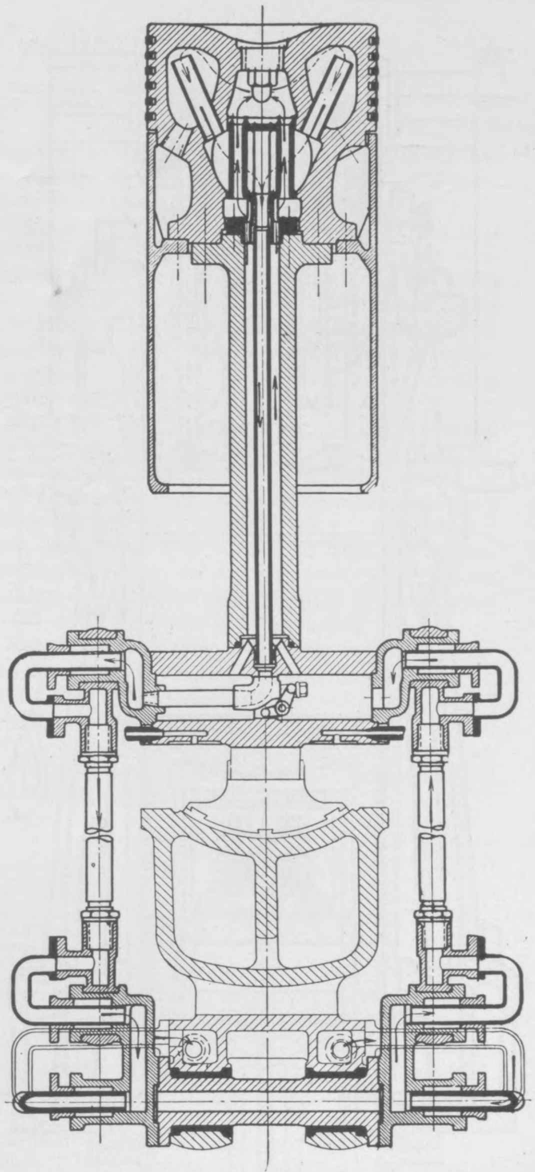


Fig. 94. Swinging joint cooling tubes

In general there are three types of mechanical arrangement by which the cooling fluid may be circulated through the moving piston. They are: 1. Trombone tubes with stuffing box, an example of which is shown in Fig. 89B. 2. Trombone tubes not depending upon stuffing boxes, but fitted with a jet for projecting the water up to the piston in the form of a stream of water (Fig. 88). 3. Swinging links of the type shown in Fig. 94.

From what has already been said it will be apparent that the tubes and joints of the piston cooling system would make it inadvisable to use any but the most moderate pressures in circulating the cooling medium through them. Engineers are generally satisfied if they succeed in getting the fluid positively to the under side of the piston crown and are glad enough merely to let it drop out of the discharge tubes after that.

As far as is known, no attempt has ever been made to include the piston cooling system in a positive pressure circuit. In the case of the positive-packed tubes illustrated in Fig. 89B, for instance, it would appear natural to lead the water from the piston discharges direct to the overboard outlets. However, the slight head which would thus be imposed on the system is considered undesirable in view of the hard usage to which it is subjected; consequently the water issuing from the piston is allowed to flow into the bilges and to be discharged from there along with the rest of the bilge water.

Practically all systems, whether oil, sea water, or fresh water is used in them, are thus characterized. When oil is used, it is allowed to drop into vertically slotted guides (Fig. 96) and is sucked from there by means of an elevating pump connected to coolers and strainers. When fresh water is used a special sump containing the suction of a special fresh water elevating pump is provided.

A typical salt water cooling system is sketched in Fig. 93. Branches from the cylinder cooling trunk are led to the trombone tubes of the piston while the piston discharges are led to a sight funnel and then to the tank top and the bilges. Water is prevented from accumulating there by the auxiliary bilge pump, which must always be kept in operation so long as the main engine is running. It forces the piston cooling water, along with the rest of the bilges, out through the overboard discharge.

Had the attempt been made to pipe the water discharged from the pistons directly overboard, the 10-ft. head indicated on the sketch would have been imposed on all the piston cooling connections.

It is apparent that the squirt cooling illustrated in Fig. 88 would not work at all without free gravity draining as there is no positive pressure in the water after it leaves the squirt nozzle in the form of a thin stream. A plainer representation of the squirt method of piston cooling and its working is given in Fig. 95. It is essential only that the pressure maintained on the nozzle be such as to give the jet sufficient length to reach the piston even in the top dead center position; the deflection of the jet to the interior of the piston is accomplished by means of the large-diameter tube with the L-bend near the top. Maintenance of the proper water level within the piston is assured by the riser on the outlet tube (right hand side) which is however kept low enough to prevent the L-bend from becoming flooded.

The arrangement shown in Fig. 95 must be regarded as more or less diagrammatic because if built in that form the splash from it would drench the engine and deposit salt inside the piston liner. For that reason the trombone tubes shown in Fig. 88 are provided, but the working principle of the latter arrangement is essentially the same as that of Fig. 95. Both of them may best be understood by bearing in mind that the squirt nozzle is fixed; the one in Fig. 88 is long enough to reach far up into the piston while the latter is at the lower dead center. The inner tube *e*, Fig 88, surrounds the nozzle and jet, although moving up and down with the piston; it corresponds to the inverted funnel of Fig. 95 and serves merely to guide the water more effectively into the piston. The outer tube *f* is stationary and answers the purpose of an additional guard against splash. Both the outer tube *f* and the squirt nozzle *c* are therefore stationary while the only moving tube in the system, *e*, dips into

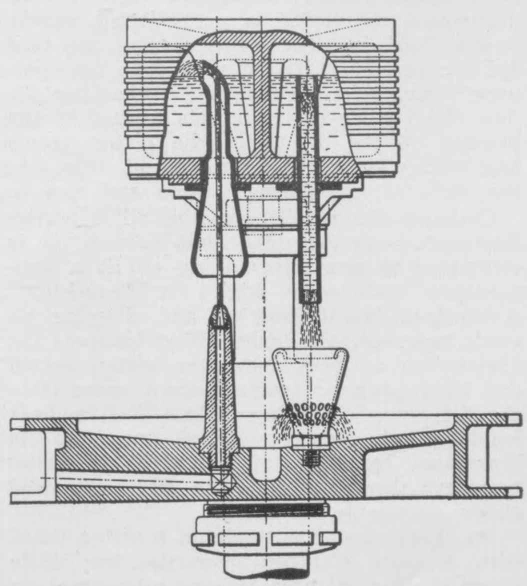


Fig. 95. Squirt method of cooling

the annular space between the two. The tubes e^1 and f^1 on the discharge side (right) are duplicates of e and f whereas the nozzle is there omitted for obvious reasons.

It need hardly be pointed out that the piston of Fig. 88 cannot fill "solid" with water both because of the opportunity for back-drainage through the annular clearance between the tube e and the nozzle c and because of the absence of a riser on the discharge tube e^1. The stuffing boxes confine all the splash and guide the tubes to prevent them from whipping and scraping.

High water pressures are required with the squirt systems and that in turn requires the use of small diameter nozzles. The latter must therefore be watched for clogging and good strainers capable of ready cleaning, must be provided in the supply line. A surprising variety of objects—from orange peel to collar buttons—may often be found lodged in the nozzles.

Sometimes the structure of the engine renders the application of trombone tubes too awkward and in such cases jointed swinging tubes like those already referred to in Fig. 94 are resorted to. As their separation from the rest of the engine moving parts is next to impossible, leakage from the many joints is sure to get into the lubricating oil of all except drip-lubricated machines. The fact that the leakage from such an arrangement is apt to be copious would in itself militate against using them for water circulation and limits them to oil as the cooling medium.

It must be borne in mind that tubular linkages are subject to considerable inertia and shaking forces which tend to produce heavy wear on the joints. As a consequence the designer is confronted by the double mechanical problem of resisting mechanical wear and maintaining tightness. In Fig. 94 it will be observed that long sleeve bearings are provided to take the wear and that the packing for tightness is accomplished by distinct and separate stuffing boxes thus relieved from all side thrust. Some designers have even gone to the length of providing ball bearings next to the stuffing boxes in order to relieve them from strain. At the same time too much bearing may defeat the very object sought after because excessive metal masses only increase the inertia and therewith add to the wear.

Sometimes the lubricating oil circulated through the hollow crankshaft, connecting-rod, and piston-pin is used for cooling purposes, a procedure which has the decided advantage of eliminating special linkage or gear for conducting cooling oil. Such an arrangement is illustrated in Fig. 96, which is self-explanatory. Note, however, that the discharged oil (left) is not allowed merely to drop back into the bedplate sump, and that for two reasons. If that were done the operator would have no means for checking the flow of oil while carbon crusts formed by the heating of the oil under the piston crown and flaking off after a time might drop into the main oil circulating system and clog it.

Carbonization of piston cooling oil ordinarily does not occur provided that enough oil is circulated to avoid its taking on at a temperature sufficiently high for "cracking." Aside from the flaking off and clogging already referred to a carbon crust hampers the abstraction of heat from the piston crown and by raising its temperature exposes it to the danger of cracking. How good a heat insulator the carbon layer may be is illustrated by Fig. 85C in which the heat transfers through both clean and carbonized piston crowns is indicated.

An experiment was made on a piston fitted with a plate clamped over the top while steam at constant pressure and a temperature of 284° F. was kept supplied to the space thus formed. Oil was then circulated through the interior of the piston at various rates and a record kept of the difference in temperature of the ingoing and outgoing oil. As long as the carbon crust remained in place the oil picked up decidedly less heat than it did after the carbon was cleaned out: the difference clearly indicates the impairment of heat transfer due to the carbon layer.

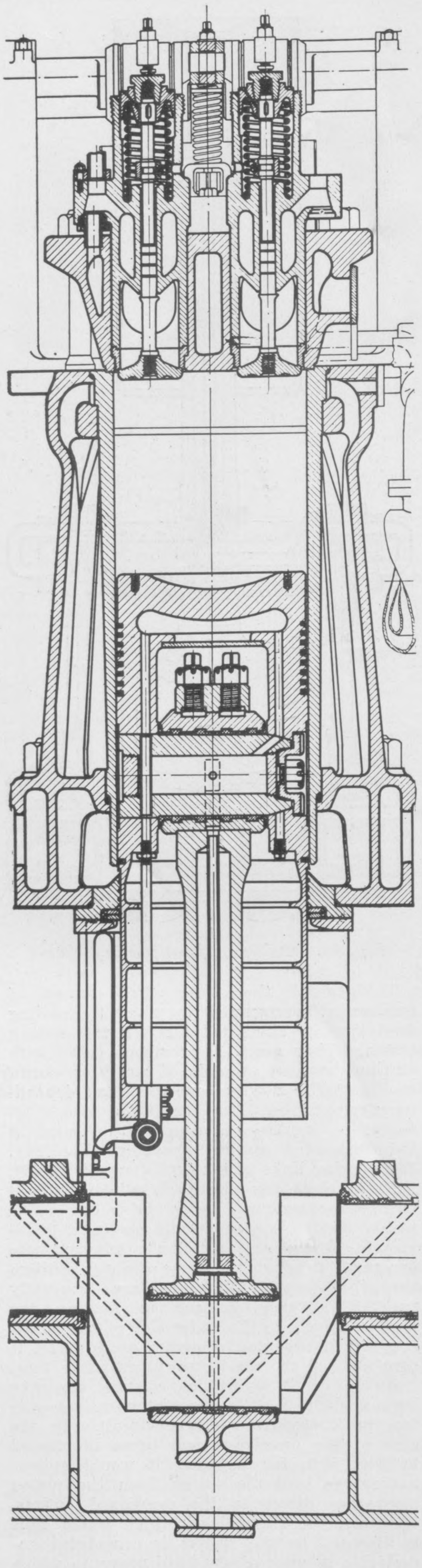


Fig. 96. Piston cooled from pressure lubricating system

Smoke issuing from the oil discharges is a warning signal that the oil in the piston is cracking and depositing carbon.

Oil has a specific heat only about one-half that of water. At the same time it is more difficult to cool back because its viscosity is increased by contact with the tubes of the coolers containing sea water. As the viscous layers thus formed next to the tubes are relatively stagnant they act as insulators which retard the transfer of heat. All in all, therefore, considerably more than double the amount of oil must be circulated if it is to abstract the same amount of heat from the pistons as would be absorbed by sea water.

It would be a mistake to draw from this discussion of piston structure and cooling the conclusion that unusual difficulties are involved. As a matter of fact there are hundreds of engines in regular service today of which the operators hardly are conscious that they contain any pistons. A fair amount of attention to the matters discussed here generally suffices to keep pistons from becoming obstreperous.

M. V. "Weirbank" Completed

The M. V. WEIRBANK, of 5,200 gross tons, one of the twin-screw motor vessels being built by Harland & Wolff, Ltd., Govan, for Messrs. Andrew Weir & Co. (Bank Line, Ltd.), was delivered last month. The WEIRBANK is a high class cargo vessel of the shelter deck type classed 100 A1 at Lloyd's, and of similar dimensions to the other twin-screw vessels recently delivered to the Bank Line.

The holds are fitted with large cargo hatches which are worked by twelve of the builders' special steel derricks, each suitable for five-ton lifts and rigged in the best manner for rapid and efficient handling of cargo. The derricks are attached to two steel pole masts and four derrick posts and an additional heavy derrick is fitted at the after side of the fore mast to deal with loads up to twenty-five tons. The twelve cargo winches and the windlass are steam driven, while the steering gear is electrically driven and controlled from the bridge by a telemotor.

Extending fore and aft the double-bottom is used for the carriage of oil fuel, fresh water or water ballast, and the vessel is divided by seven bulkheads extending to the upper deck into five cargo holds, motor room and fore and after peaks. The propelling machinery consists of two sets of six-cylinder Harland-B. & W. motors, and the auxiliaries are electrically driven.

Engines Destroyed by Fire

Of the twenty-six Winton 150 s.hp. Diesel engines recently built for the U. S. Coast Guard, thirteen were irretrievably destroyed by a general warehouse fire and the balance were saved. Since then two more 150 s.hp. Winton Diesels have been ordered.

Three Oil Engines for Dredge

Three Bessemer oil engines will be installed in an 80' x 30' steel dredge building for the Florida and Southern Dredging Co., St. Petersburg, Fla. A 450 b.hp. unit will drive the pump, a 125 b.hp. unit will be on the cutter, and 100 b.hp. will be on the winches.

Diesel Engine for Workboat

The Hicks Engine Works, of San Francisco, Cal., recently completed their first Diesel installation on board a workboat. This engine is a three-cylinder, 50 b.hp. unit, operating on the high pressure airless injection system.

Our Readers' Opinion

(Publication of letters does not necessarily imply endorsement of views expressed.)

To Editor of MOTORSHIP:

The article, appearing in your August Number of MOTORSHIP and purporting to give a comparison of two Sister Ships, owned by the Nippon Yusen Kaisha, and equipped respectively with 2-cycle Sulzer engines and 4-cycle Harland & Wolff-B. & W. engines, is inaccurate and misleading.

It is specially to be criticized in the use of loose exaggerated statements, atributed to the chief engineer of the 2-cycle vessel, as a basis of these comparisons. For example, he is quoted as saying the 2-cycle engines and auxiliaries of his vessel are about half the weight of the 4-cycle sister ship. This is entirely wrong as will be shown later.

It is stated that the engine room of the 2-cycle ship is 56 feet as against 64 feet for the 4-cycle. Actually the 2-cycle takes 20 frames or 53 feet 4 inches between main engine bulkheads, as against 23 frames or 61 feet 4 inches for the 4-cycle. Had the Standard B. & W. engines of 6 cylinders each of 740 m.m. diam. and 1300 m.m. stroke and 4500 s.hp. at 125 r.p.m. been used the length could have been reduced to 19 frames. The engine builders no doubt had certain reasons for using the 8-cylinder engines with twin air compressors requiring the larger engine room to make use of existing patterns and jigs, and there was probably nothing to be gained by having a smaller engine room space for this particular vessel.

In reference to comparative weights it should not be overlooked that, although the nominal rating of the two sets of engines are the same due to the same designed speed, the actual output, on a standard 90 m.i.p. at their designed revolutions, is about 300 s.hp. more for the 4-cycle engines. In actual service there will be still more difference due to the higher sustained m.i.p. which can be used with the 4-cycle engine, and possibly accounting for the higher speed of the 4-cycle vessel on the Pacific voyages referred to in the article. Published data by Sulzer Bros. gives the weight of similar engines of same bore but 100 m.m. less stroke, with scavenging blowers at 420 tons, while the weight of the 8-cylinder B & W engines is about 575 tons. The three auxiliary engines, shafting and propellers will be 30 tons lighter for the four cycle installation, while the maneuvering compressors and other auxiliaries can be taken the same for the two ships. This gives a net difference of 125 tons heavier for the 4-cycle installation but which is justified by its higher sustained power it is capable of developing continuously in service, as before stated.

Had the 6-cylinder engines above referred to, weighing 540 tons, and the smaller B. & W. auxiliary engines, running at 400 instead of 300 r.p.m., having oversize compressors and eliminating the maneuvering compressor, been employed the weight of the 4-cycle installation could have been reduced 60 tons making a net difference of only 65 tons compared with the 2-cycle installation.

Assuming the weight of the two-cycle machinery as 850 tons, the comparison becomes as follows on a basis of 90 m.i.p. for rated powers, using 83% mechanical efficiency for the 2-cycle engine with separately driven scavenging compressor and 77.5% mechanical efficiency for the 4-cycle engine.

	Sulzer Installation	B.& W. 8-cylinder Installation	B. & W. 6-cylinder Installation
R. p. m. designed...	100	125	125
S. h. p. designed ...	4,000	4,300	4,500
Comparative s. h. p..	1	1.075	1.125
Total weight	1	1.145	1.075
Comparative total weight corrected for designed power	1	1.065	.955
Engine room length	1	1.15	.95

It is to be hoped that the owners will release, in the course of time, authentic data on these vessels giving the powers, speed and fuel consumptions in actual service, up-keep, delays at sea, etc., which will give ship owners a true idea as to the respective merits of these two vessels. The article in question only serves to mislead.

J. C. Shaw,
Assistant to Chief Engineer,
The Wm. Cramp & Sons Ship & Engine Building Co.,
Philadelphia, Pa.

15,000-B.hp. Engine

BLOHM & VOSS, of Hamburg, are building a 9-cylinder double-acting 2-cycle engine of 15,000 b.hp. for the power station of the free port in Hamburg. This has previously been mentioned in our columns. The German correspondent of "Fairplay," London, is responsible for the following interesting information:

"The cylinders will be 33¾ in. in diameter, the stroke of the piston will be 59 in., and the engine will develop its power at 94 revolutions per minute. It is to be coupled with a generator of 11,000 kw. In the development of the new type, he says, the main task was to find, by means of careful investigations, a good system of port scavenging which did not require too much power for the purpose. Valve scavenging might, it is true, have been used, as was done in the 12,000 h.p. experimental engine for naval purposes built by the M.A.N. during the war; but a solution of the problem on these lines would have involved the use of a large number of cumbersome valves and complicated castings. The result of the port scavenging experiments was the adoption of a design in which the ports for the entrance of the scavenging air and the exit of the exhaust gases occupy only a part of the periphery of the cylinder wall and are arranged on the same side above each other.

"There are altogether four rows of ports. The upper and lower are the exhaust ports and those in the middle the scavenging ports. One pair serves for the cylinder above the piston, and the other pair for the cylinder below the piston. As the piston descends it first uncovers the upper row of discharge ports and allows the gases to pass. Then it uncovers the scavenging ports. Tne air stream which enters through them is directed over the top of the piston against the opposite cylinder wall, where there are no ports. It ascends the wall, carrying the exhaust gases before it, descends on the side where the ports are, and finally leaves the cylinder through the exhaust ports.

"They consist of two concentric sections, the inner of which has horizontal ribs for the passage of cooling water. The upper cylinder cover is divided into two parts in order to allow more intensive cooling of the lower part, which is in contact with the hot combustion chamber. The fuel valve, the starting air valve and the safety valve are arranged in a single hole in the cover. The bottom cylinder cover has four separate fuel valves, grouped around the piston stuffing box; the mean indicated pressure under the piston is thus made equal to that above the piston. The stuffing box is of the normal construction used in large gas engines,and,has,metallic rings. The piston is cooled by water, which passes through the hollow rod into the piston and also returns through it. Special measures have been taken to insure that no leaking water shall contaminate the lubricating oil. All valves—those upon the upper covers as well as those at the bottom of the cylinders—are operated by a camshaft which lies at the level of the cylinder top. The lower valves are connected to the camshaft by levers and push rods. Extra ignition oil pumps are provided, it may be added, to engines of this type, so that tar oil may be used for driving it if necessary.

"Some experimental engines of the type have been built, including a 2-cylinder motor of 1600 hp. and a single-cylinder motor of 1100 hp. The latter, which is the more recent, has undergone a series of severe test bed trials. It has a bore of 800 millimeters and a stroke of 1050 millimeters, and developes its designed power at 100 revolutions. The mechanical efficiency worked out at 80 per cent, and the consumption at 185 grammes per brake horsepower. The weight of the double-acting two-cycle engine is stated to be about 35 per cent less than that of a single-acting two-cycle engine of similar design and revolutions. The savings in first cost run in the same line, but apart from that, the increase in deadweight capacity has to be taken into account."

Diesel Electric Barges

As a result of an intensive study of the operation of motor barges used by the Pacific Coast oil companies in duties similar to those for which the new barge just ordered by the General Petroleum Co. from the Bethlehem Shipbuilding Corp. is intended, the purchasing company has specified Diesel electric drive.

The new barge, wihch is to be completed by Jan. 1, 1925, will be used in a strictly local trade, refueling ocean-going vessels while in port and transferring oil from tankships to the company's shore tanks at Oakland. Her capacity will be 6000 bbl. of cargo oil and about 20 tons of fuel for her own use. The leading characteristics will be as follows:

Displacement, light	1000 tons
Deadweight capacity	6000 bbls.
Length overall	176 ft. 6 in.
Length b.p.	170 ft. 0 in.
Breadth amidships	32 ft. 0 in.
Draft amidships	14 ft. 0 in.
Draft, mean loaded	11 ft. 6 in.
Speed, estimated	9 knots

Power will be provided by two Atlas-Imperial 250 b.hp. 6-cylinder engines driving Westinghouse generators, furnishing current for a 350 s.hp. electric propelling motor. The handling of oil will be accomplished by two Northern pumps of a capacity of 1000 bbl. per hour each, to be driven by individual 60 hp. Westinghouse motors. Other features are:

Power of Diesel engines	500 b.hp.
Cylinder diameter	11½ in.
Piston stroke	15 in.
Engine speed	275 r.p.m.
Estimated fuel consumption	25 gal. per hour
Lubricating oil consumption	½ gal. per hour
Engineroom staff	2 men

The electrical equipment will include remote control from the bridge of the vessel, a great advantage in coming alongside large ships to be fueled as they lie at the piers.

This vessel will be the first Diesel-electric vessel tried out by the General Petroleum Co.

An order for two 95 ft. Diesel electric tugs to cost about $250,000 was placed recently by William Wrigley, Jr., for the Wilmington Transportation Co., of San Pedro, Cal. The two new boats will be named the JOHN N. STEWART and M. S. PATRICK respectively. Both will be driven by Winton engines of 500 hp. The Wilmington Transportation Co., which is largely engaged in the traffic between the Catalina Islands and the California mainland, already owns Diesel engined tugs of large power.

Messroom Maxims and Fables

A GOOD way to get the port engineer's goat is always to have a long repair list to hand him.

However, it seems that no matter how well the voyage has panned out the port engineer can think of something which might have been done better.

A few handfuls of waste left in the crank-pits is a good way to burn out some bearings.

Rotten meat on the table either indicates a careless cook or an indifferent engineer, either one or both of whom should be fired.

Make a trip down the shaft alley once in a while.

Now is'nt it hell when a spare part is badly needed and it is found to be all rusty and out of working order?

One of the best ways to keep from being hired is to present a long tale of hard luck along with your references.

The engineer who hacks up nuts with a chisel and hammer plays a dirty trick on the engine.

The shipowner who will not supply suitable tools is responsible.

No use to try to start the engine with the air shut off.

By taking a look at the propeller before jacking the engine the jacking gear may be saved a nasty breakup.

When the engine does not start well it is a good plan to check up on clearance volume.

But of course we should have the fuel valve primed, the air on, etc.

A place for everything and everything in its place. Old stuff! You bet—but good.

If the ship don't suit us it seems that we will have to put up with it. If we don't suit the ship some one else probably will.

It may be troublesome to take indicator cards, but that's part of your job.

Pays to grind exhaust valves before they start leaking.

A thermometer is not an alarm clock.

However, there are some good low pressure alarm systems:

But that don't keep anyone awake.

If there should be a bad valve in the compressor it won't do any good to swear about it. Fix it.

Clean gratings and a clean shave are much alike in that both give a dressed-up appearance.

Spending ten dollars' worth of time to save ten cents' worth of material is poor economy.

At the same time that doesn't justify us in breaking things up.

One bright idea a day is enough.

It has come to a point that a motorship engineer must be a steam engineer and electrician as well as a machinist.

That should knock the wiseacre cold that remarked about an engineer being a man too lazy to work and too dumb to be a machinist.

When the valves in the scavenging air pump are dirty combustion will be dirty.

Don't be too sure the engine is not properly designed more especially if it has been running well for several years and you have just made the discovery.

But if it should not be designed just right would you do everything to the designer you sometimes say you would like to do?

The man who simply has to get drunk once in a while should do it ashore if he wants to keep his job: Even at that he runs a "Broody."

Very few men who are chock full of theory have room for practical things.

However, a little theory tempers the metal of our practical foundation.

If someone else gets the advancement don't be too sure that "pull" did it. There are more opportunities and advancements in this world than "pulls."

Bad business to use a piece of pipe on the handle of an 8-inch pipe wrench.

Tradition seems to have taught the black gang to be antagonistic toward the deck force, but even tradition does not justify us in smearing dirt over the mate's white paint.

No use to say the air bottles will not stay charged in port if the valves need grinding.

Run the auxiliary compressor occasionally to keep it in order and know it is all right.

Drop things in the bilge, leave them there, then swear because the bilge pump will not clear the ship of water.

Gas-Skinner vs. Steam-Man

Not many years ago the "gas-skinners" used the following story as a stock joke and told it whenever they gathered at one place at the same time.

The chief engineer of a certain motorship was a steam engineer without motor experience—was placed there because he had a "pull." His first assistant was a "gas-skinner" who knew his stuff and was there because the chief couldn't run the job without him.

One day at sea the first came to the chief's room and addressed his superior. "Say, chief, there's something wrong with No. 5 cylinder on the starboard engine."

"All right, mister, just bring it up, and I'll have a look at it," the chief replied without moving from his chair.

That was wartime.

The war is over, but a misapprehension still exists among the "gas-skinners." Steam engineers make good motorship engineers. They are not trying to steal any one's job, and 99 per cent of them do not know that there ever existed such a thing as a "gas-skinner." We never heard one raise the question as to who is who. They do expect that as new ships are built there will be more jobs and they will have a show among others.

"Gas-skinner" is the nickname which the small motorvessel engineers gave themselves. They were a clannish crowd, jealous of an invasion into their work by outsiders, particularly Y. M. C. A. students and steam men—and they placed one on about a par with the other.

Many of the boys knew A. B. N. as a "gas-skinner." It is our intention to make you smile, or swear. To flapperize our line, we hope to give you a thrill.

We have been accused of writing propaganda in favor of steam men. In a letter comes a breath of the Alaskan coast, a whiff of the fish canneries stench, a tumbling about outside of Kodiak Island and the bustle and rustle of the Halibut Exchange on Pier 8 in Seattle. We see the fleet of boats at Neah Bay and remember the rainy days in West Pass buying dog-salmon.

Many of the best motorship engineers would not care to admit that their preliminary training started in that sort of work. They do not want the steamship engineers to have the same sort of a laugh on them that they had on the unworthy chief who thought No. 5 cylinder on the starboard engine was carried in the boatswain's ditty bag.

Others are good, and know they are good. They don't give a damn what any one says about where they started. They are fully aware of the important nature of the western pioneering in the motorship field.

Thus when a letter comes in from one of the old contemporaries, who has not stepped up into the big ships along with the rest, we sometimes wonder if he is not the one who sat in the corner of the room and shouted, "Bring her up and let us look her over," when a chief engineer of an old time auxiliary motor-schooner came in and asked for a man to sail as second assistant for him. A. B. N.